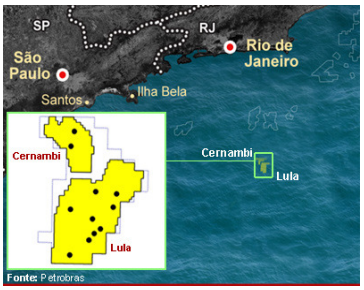
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CASE HISTORY BRIEF 2018 • 02S

Newpark's X-Prima Successfully Applied to Combat Losses in Pre-Salt Well Drilled With MPD Technology



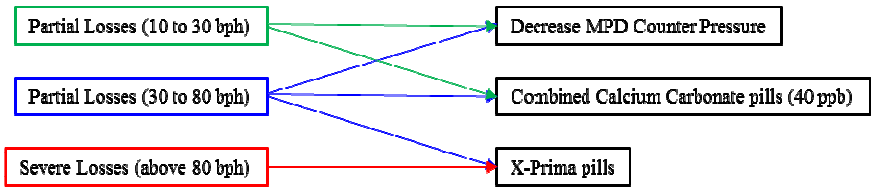
Petrobras has performed New X-Prima pills at the Lula Alto field (Well 7-LL-66-RJS) in Santos Basin enabling the drilling of the 12 ¼"MPD interval at reservoir section

Challenge

Lula Alto field is located at Santos Basin, 206 km off the coast of the Rio de Janeiro state. The main objective is the Microbial Calcium Carbonate reservoir in Barra Velha Formation (BVE-100) bellow the salt formation where major loss circulations where predicted at planning stages (microbial Vugs and natural fractures expected on the formation). The program was to drill the well in four intervals until 5298 m. The reservoir interval was to be drilled with 12 1/4" Impregnated Drill Bit with HiPower Turbine, Paraffin SBM and MPD System. After drilling the reservoir until the first target with severe losses, the challenge was to enable running wire line logs successfully. Three X-Prima Pills were successfully performed during drilling the interval.

Recommendation/Plan

The interval was planned to be drilled with a 12 1/4" Impregnated Bit with HiPower Turbine from 4863 to 5298 m (435 m). As the pressure window was too narrow, MPD System was used to mitigate the risk of Kicks and Loss Circulation. In the event of a circulation loss, Calcium Carbonate and X-Prima pills should be pumped according decision matrix. For the X-Prima pill case, a bypass through PBL valve was included in the procedure as recommended by MWD/LDW tools representative. As TD was reached, the program was to condition the open hole, perform wireline logs, run production casing and perform cement job. Below it is presented the simplified schematic includeed at the drilling program for the cases of Circulation Loss:



Cement plugs would only be used as last option. A batch mix was sent to the rig as contingency to prepare the pills.

Formulation:

Table 1 - X-Prima formulation considered at the drilling program

Material	Concentration, ppb
Fresh Water	-
Xanthan Gum	0.5 – 1.0
New X-Prima	110.3
New Bridge	6.0

Execution

Due to several stuck pipe events and fishing operations required, the MW had to be increased at the end of reservoir section to above value established in the drilling program. As a consequence of the overbalance created by the higher MW, loss circulation was observed from 5065 to 5219 m. In order to combat, the operator decreased the flow rate, the Anchor Point (MPD) and Calcium Carbonate pills were pumped, all of these without significant results observed.

Moving on as per established on the decision tree diagram at the mud program, three X-Prima pills were pumped and completed eliminated the losses.

Pill #01 (MPD)
Drilled from 4876 to 5065 m (189 m) with 27-37 Klb, 50-80 RPM, 5-7 Klb.ft, 600-820 gpm (300 gpm Booster Line), 5120-5500 psi, MW 8.9 ppg (SBM), ROP 2.6-3.7 m/h, SBP 330-350 psi, Anchor Point 9.58 ppg (casing shoe). Circulation loss registered at 5065 m at rate of 200 bph in dynamic conditions. A 100 bbl of Calcium Carbonate pill was pumped, Anchor Point was reduced to 9.53 ppg and the flow rate was also reduced. At this point, the circulation loss decreased to 80 bph at dynamic conditions. Following, it was decided to pump X-Prima pill previously prepared in the Batch Mix.

Pill #02 (MPD)
Drilled from 5065 to 5134 m (69 m) with 30-35 Klb, 60-80 RPM, 4-8 Klb.ft, 820 gpm (300 gpm Booster Line), 5200-5250 psi, MW 8.9 ppg (SBM), ROP 3.5 m/h, Anchor Point 9.56 ppg (casing shoe). Circulation loss registered at 5134 m at rate of 30 bph in dynamic conditions. A 100 bbl Calcium Carbonate 40 ppb pill was than pumped with no success. Losses still registered from 30 to 45 bph in dynamic conditions. Decision was to continue drilling until 5134 m, point in which it was decided to pull the drill string to the shoe due to very low ROP. As the losses were still observed, before tripping out of the hole, it was decided to pump another X-Prima pill. While mixing the X-Prima pill, a 120 bbl of Calcium Carbonate 40 ppb was pumped and losses were still observed at around 25 bph in dynamic conditions.

Pill #03 (Standard)
Drilled from 5134 to 5219 m (85 m) with 10-30 Klb, 60 RPM, 4-8 Klb.ft, 700-740 gpm (300 gpm Booster Line), 4130-4500 psi, MW 9.5 ppg (SBM), ROP 1.3-3.2 m/h. Since the first meters of drilling, loss circulation ranged from 2 to 25 bph in dynamic conditions. At approx. 5219 m, losses escalated to 25 to 60 bph in dynamic conditions. At this point, 145 bbl of Calcium Carbonate 40 ppb pill was pumped with no success, as losses remained the same. Drilling continued until losses reached 120 bph in dynamic conditions. Decision was to pump a non-balanced X-Prima pill.

Procedures for Pills #1, #2 and #3:

Pill #01 and Pill #02:

- Open PBL valve (spheres activated valve);
- Pump 50 bbl of pill with Pump Unit (Batch Mixer) and displace balanced plug with SBM through PBL valve placing the pill in the annulus;
- Pull the drill string positioning the bit above the X-Prima pill theoretical top (maintained the SBP in 500 psi);
- Circulated with 500-550 gpm, Anchor Point at (casing shoe) 9.53 ppg and SBP 350-400 psi;
- Squeezed pill using MPD system:
    - Hesitations cycles were performed in steps of 25 psi (SBP) using MPD counter pressure;
    - Target SBP was 500 psi, Anchor Point (casing shoe) around 9.7 ppg;
- Performed dynamic flow check;
- *Observation:* After circulating and performing first meters drilling (Pill #01), it was observed X-Prima pill returning in the shale shakers:
    - Stopped drilling till X-Prima pills were 100% out the shakers and the drilling flow rate could be reached;
    - Did not observed in Pill #02 because the procedure was performed to BHA trip in order to change the bit;

Pill #03:

- Open PBL valve (spheres activated valve);
- Turned o Booster Line pump at 300 gpm;
- Pump 100 bbl of pill with Pump Unit (Batch Mixer) and displace with SBM through PBL valve placing the pill in the annulus;
- Pull the drill string positioning the bit at casing shoe depth;
- Place drill string in hang off position, close BOP (upper annular ram), align mud pumps to Kill Line and close IBOP valve (DDM);
- Squeezed pill through drill string, performing hesitations steps and monitoring pressures:

Table 2 - Cycles x Pressure drops at application of Pill #3

Cycle	Pressure (psi)	Pressure Drop Rate (psi/min)
1	300	0
2	300	25
3	300	16
4	500	12
5	500	16
6	300	12
7	300	12
8	300	12

** Presure is the Hesitation Target pressure*
*** Presure Drop Rate is the pressure rate after achieved the target pressure*

- Static flow check (Trip Tank) performed, no problems observed;

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- After circulating and drilling first meters, it was observed X-Prima pill returning in the shakers. Stopped Booster pump until shakers clear.

Results

Well	7-LL-66-RJS		
OH Diameter	12 ¼"		
Water Depth (m)	2138		
MD (m)	5065	5134	5219
TVD (m)	5065	5134	5219
Litology	Microbial Calcium Carbonate		
Formation Characteristics	Vugs and Fractures		
PP (ppg)	9.40 (DPPT)		
FLUID	BR-MUL (Petrobras SBM)		
MW (ppg)	8.9	8.9	9.5
Over Balance (psi)	150 (casing shoe)	150 (casing shoe)	~90
Pill Volume (bbl)	50	50	100
Before bbl/h (static)	Not Informed	Not Informed	Not Informed
Before bbl/h (Dynamic)	200 / 80	30 / 25	120
After bbl/h (static)	0	0	0
After bbl/h (Dynamic)	0	0	0

Summary/Operator Benefits

Calcium carbonate formations below the evaporitic sections have been a big challenge in pre-salt wells. Great vugular pores and natural fractures have been encountered in which several losses have been experienced. The success of the X-Prima pills application has enabled the operator to drill the interval to TD and carry on successful wire line logs without drags or stuck threats during these operations.

Even when MPD technology is applied, the X-Prima system has been confirmed as an effective alternative to combat severe losses due to its results on reducing and/or eliminating these issues at these formations.

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Glossary

Vugs - small to medium-sized cavity inside the rocks (formations).

MPD (Managed Pressure Drilling) - is as an adaptive drilling process used to precisely control the annular pressure profile throughout the wellbore.

TD (Total Depth) - is the final depth of a well or interval.

IBOP (Inside BOP) - is a back pressure valve used in the Top Drive to prevent the well from flowing uncontrollably up the drilling system.

DDM (Derrick Drilling Machine) - same as Top Drive.

ROP (Rate of Penetration) - is the amount of formation drilled per an specific period of time.

SBP (Surface Back Pressure) - is the back pressure set in the surface to control the annular pressure in MPD drilling.

Anchor Point (Point of Constant Pressure) - is the mud equivalent density set in the MPD system to control annular pressure.

BHA (Bottom Hole Assembly) - all drill string tools installed to drill an interval.

PBL (Bypassing valve) - Bypass valve above MWD/LWD placed in the BHA.

Unit used - ppb (pounds per barrel), ppg (pounds per gallon), gpm (gallons per minute), m (meters), ft (feet), Klb (kilo pound), RPM (rotations per minute), psi (pound square inch), bph (barrel per minute), bbl (barrel), m/h (meter per hour).