Overcoming Challenging Narrow Mud Weight Window of 0.35 ppg: Successful MPD & MPC Application in Offshore Malaysia - A Case History

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Field Location

Malaysia Map

TA WELL
TA Well Background

While drilling 6” hole:
- Fracture: 18.3 ppg
- Pore Pressure: 16.7 ppg

Cementing deemed impossible, suspended

TA Well revisit planned with MPD applications

Planned well TD: 2350 m-MD
### 6” Hole MPD Plan

<table>
<thead>
<tr>
<th>OPTION 1</th>
<th>OPTION 2</th>
<th>OPTION 3</th>
<th>OPTION 4</th>
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</thead>
<tbody>
<tr>
<td>FG &gt; 18.9 PPG</td>
<td>18.6 &lt; FG &lt; 18.9 PPG</td>
<td>18.3 &lt; FG &lt; 18.6 PPG</td>
<td>18.1 &lt; FG &lt; 18.3 PPG</td>
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<tr>
<td>MAX PP = 18.1 PPG</td>
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- Drill MPD with MW > PP.
- Once TD, displace the well conventionally at TD.
- POOH Conventionally.
- Run the liner conventionally.
- MPD Cementing if required.

- Drill MPD with MW < PP.
- Once TD, kill the well at TD.
- POOH Conventionally.
- Run Liner conventionally.
- Perform MPD Cementing.

- Drill MPD with MW < PP.
- Pump LCM pill to cover open hole.
- SOOH to the shoe holding set point.
- Kill the well at Shoe.
- Run liner and displace to lighter mud as per schedule.
- Perform MPD Cementing.

- Drill MPD with MW < PP.
- Pump LCM pill to cover the open hole.
- SOOH to the shoe holding set point.
- Top kill well.
- Run liner and displace to lighter mud as per schedule.
- Perform MPD Cementing.

**Worst case**

- **Shoe DLOT =** 18.6 ppg
- **Actual Well Results =** 0.35 ppg
- **PP =** 17.82 ppg
Plan Versus Actual of Drilling Phase

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**PLANNED**

**ACTUAL**

Prognosed PP (ppg)  
Prognosed FG (ppg)  
Actual PP (ppg)  
Drilling MW (ppg)  
ECD + SBP (ppg)

**0.35ppg**
Well was top-killed with 18.3 ppg mud at 1200m, 18 ppg EMW @ TD (50psi overbalance).
RUNNING LINER AND UNDERBALANCED FLUID DISPLACEMENTS

600m
18.3 ppg

1200m
17.9 ppg

1700m
17.9 ppg

2350m
16.3 ppg

7” Top of Liner @ 1890m-MDDF

7” Shoe @ 2010m-MDDF

TD @ 2350m-MDDF
4-1/2” Liner Displacement
4-1/2” Liner Managed Pressure Cementing (MPC) Challenges

• Constant bottom hole pressure
• 0.35 ppg pressure window
• Zero human error – communication
• High static underbalance – 640psi
• Well loss & gain
Managed Pressure Cementing Plan (without SBP)

FG = 18.5 ppg (as per cementing company simulation, calibrated to equivalent of 18.17 ppg) to the actual PP = 17.82 ppg.

Operating Window

- ECD At 2305m (ppg)
- ECD at 2010m (ppg)
- Max PP (ppg)
- Min FG (ppg)
- SBP Plan during Cementing Operation (psi)
- Skurry Rate (gpm)
Managed Pressure Cementing Plan (with SBP)

Operating window

FG = 18.5 ppg (as per Cementing Company Simulation, calibrated to equivalent to 18.17 ppg) to the actual. PP = 17.82 ppg.
Actual Managed Pressure Cementing Graph

- Weighted spacer
- Cement slurry
- Displacement
- Wash spacer
Cement Quality

- Liner cementing without gains / losses.
- USIT log result below previous shoe
Conclusion

• Cementing possible in marginal pressure window.

• MPC success depends on:
  ◦ Valid hydraulic simulations.
  ◦ Reliable MPD system.
  ◦ Personnel training, communication protocols & clear procedures

• Successful MPC set new standard for operator.

• Exploring full MPD utilization:
Appreciation

PETRONAS
MISWACO

Acknowledgement

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