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Managed Pressure Drilling:
Drill the Un-Drillable

Lecturer’s Name: Hani Qutob
Reservoir Engineering & UBD/MPD Advisor
Senergy GB Limited– Dubai, UAE

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Distinguished Lecturer Program
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Presentation Outlines

- Reservoir Engineering & Advanced Drilling Technology
- Advanced Drilling Technology Variations
- What is Managed Pressure Drilling?
- Optimal Redefined Time/Cost line
- Variables that can be Manipulated during MPD
- What Are the Main MPD Benefits?
- Managed Pressure Drilling Variations.
- Health, Safety and Environment Issues
- Case Histories obtained worldwide.
- Conclusions
- Acknowledgement
Advanced Drilling Technology® (ADT®) & Reservoir Benefits

How ADT® can increase reserves and improve recovery

✓ Minimizes Formation Damage - UBD.
✓ Accesses Challenging Reservoirs - MPD.
✓ Improves Reservoir Characterization - UBD
✓ Identifies Missed Pay – UBD.
✓ Increases Production & Enhances Recovery - UBD / MPD
How Managed Pressure Drilling – MPD Benefits the Reservoir?

By: Accessing Challenging Reservoirs

The single biggest reserve contribution of MPD is found to be access to reservoirs that could not be drilled conventionally.

In almost all cases, MPD is used in challenging or partially depleted reservoirs, only after conventional wells prove expensive, unsuccessful or un-drillable.

Some reservoirs that could be difficult to access using conventional drilling techniques are:

1. Low pressure & depleted reservoirs
2. Vuggy/fractured carbonates where OB circulation is impossible
3. Reservoirs with a narrow margin between fracture pressure and pore pressure - kicks/losses cycles
ADT® is an adaptive drilling process which enables a more precise control of wellbore pressures through the use of engineered equipment & processes.

**ADT® Variations**

**Air Drilling**

*Improve Drilling Economics* - *Intent is to invite surface flow*
*Primarily non-liquid hydrocarbon formations*

**Underbalanced Drilling:**

*Maximize Reservoir Value* - *Intent is to invite surface flow*

**Managed Pressure Drilling:**

*Optimize Drilling Process* - *Intent is not to invite surface flow*
What is common in ADT Variations?

Personnel and Equipment
UBD, MPD & Conventional
What is Managed Pressure Drilling?

A closed and pressurizable mud-return system, a Rotating Control Head, and choke. Operations provide precise control of the wellbore pressure profile.
Reactive vs Proactive MPD

**Reactive**
- Effective on “standby” basis as an enhanced form of passive well control to help manage unexpected downhole pressure.

**Proactive**
- Used to mitigate drilling hazards and reduce NPT by changes to fluid, casing and open-hole programs.
We like prospects with big drilling windows...

EMW Must Stay Within Drilling Window For Drilling To Progress
Remaining prospects not cooperating very well

Very narrow or relatively un-known margins
Difficult or impossible to drill conventionally

When MPD is used?
- Kick-Loss Scenarios
- High mud bill
- Excessive casing string(s)
- Drilling NPT – Exceeding AFE
- Environmental issues
- Failure to reach TD with large enough hole for optimum well production
- Or…simply …. “not drillable”
MPD VALUE - VISUALIZATION

Real Well – Case 1

- Stuck pipe Fishing: 10.3% of total cost
- Stuck pipe Well flowing: 11.0% of total cost

NPT distribution:
- Well control, 10%
- Circulating, 23%
- POOH, 3%
- RIH, 4%
- Reaming, 5%
- Stuck pipe, 55%
MPD VALUE - VISUALIZATION

Real Well – Case 2

- Losses Cement squeeze: 2.3%
- Gas kick, well control: 10.5%
- Cement plug: 17.7% of total cost
- Sidetrack: 20.9% of total cost

Time distribution (well):
- NPT: 45%
- Effective time: 55%
MPD application is focused on achieving the well construction “Optimal time and Cost” as objective.
Conventional Drilling

Bottom hole circulating pressure is manipulated by only two variables.

\[ \text{BHCP}_{\text{conventional}} = \text{Hydrostatic Pressure} + \Delta P_{\text{friction}} \]

Affected by Density

Affected by density and flow rate
Managed Pressure Drilling

\[ \text{BHCP}_{\text{MPD}} = \text{Hydrostatic Pressure} \]

Affected by density

\[ + \Delta p_{\text{friction}} \]

Affected by density and flow rate

\[ + \text{Choke} \]

Manipulated from surface
Variables that can be Manipulated

Variable
- Mud density
- Mud viscosity
- Flow rate
- Trapped Pressure
- Friction Pressure

Equipment
- Rotating Control Head
- Choke Manifold
- Mud pumps
- Downhole pump
In what cases can MPD add value?

- Drill to the target
  - Drilling Exploratory, Appraisal or Challenging Development wells
  - Drill conventionally “Un-drillable” tight Pore Collapse Fracture pressure gradients
  - Drill “Un-drillable” vuggy/ fractured carbonates where Over Balanced circulation is impossible
What Are MPD Benefits?

Cost Saving

- Reduced number of loss/kick occurrences
- Reduced time spent dealing with well control events
- Earlier kick / losses detection
- Optimized number of casing strings

Improved Safety

- Trip safely
- Remove H₂S hazard from rig floor
- Drill HPHT wells safely
MPD – Added Drilling Performance Value

Geo-mechanical Issues

- Low Wellbore Pressure Differential
  - Major Kick or Blowout
  - Oriented Shear Failure Wellbore Collapse
  - Non-Oriented Splintering
  - Stable Wellbore
  - Hole Ballooning
  - Hydraulic Fracturing

- High Wellbore Pressure Differential
  - May produce angular caving visible in surface returns
  - Pore pressure "pops chips into Wellbore"
  - Well "breathes", alternately producing and taking fluids
  - Major fluid losses
MPD Variations – Visualization

- Returns-flow-control (HSE)
- Constant Bottom Hole Pressure (CBHP)
- Pressurized mud-cap drilling
- Dual gradient MPD
An adaptive drilling process used to precisely control the annular pressure profile throughout the wellbore. The objectives are to ascertain the downhole pressure environment limits and to manage the annular hydraulic pressure profile accordingly. MPD is intended to avoid continuous influx of formation fluids to the surface. Any influx incidental to the operation will be safely contained using an appropriate process.
Risk Management

With all MPD operations a detailed risk assessment as well as a HAZID and HAZOP should be carried out with the rig crew supervisors and the relevant service providers and operator staff.

Understanding the sequence of events and when to initiate MPD operations and discussing the rig up, pressure testing and operational aspects of a job together with all of the procedures will help to ensure the maximum success for an MPD operation.
Health, Safety and Environment Issues

• HAZOPs and HAZIDs are both systematic processes to identify hazards.

• “You cannot manage what you don’t know.”
No Compromise on Rig safety – all rig safety Equipment Remains unchanged
Case History 1 – Middle East

Objectives

- To reach the target depth with minimum NPT
- To avoid uncontrolled event by maintaining a constant bottom hole pressure

<table>
<thead>
<tr>
<th>8 3/8” Section Performance</th>
<th>Offset Well</th>
<th>MPD Well</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total days spent on drilling the section</td>
<td>65</td>
<td>40</td>
</tr>
<tr>
<td>Total days spent on well control events (NPT)</td>
<td>7.6</td>
<td>1.1</td>
</tr>
<tr>
<td>Total days spent on tight hole/reaming</td>
<td>2.8 days</td>
<td>19 hours</td>
</tr>
</tbody>
</table>

Saudi Arabia (Onshore)
Case History 2 – North Africa
Algeria – drilling through high fractured zone

Un-drillable Reservoir Drilled

A total of 191 m were drilled with a very small drilling window.

Zero LTI’s or near misses recorded on this well.

Avoided kick/loss cycles & Improved ROP.
Case History 3: Offshore India

MPD Added Value

NPT reduced to 1 day compared to 10 days experienced in the three previous wells drilled.

LOC & Fluid losses minimized to 290 BBL compared to 4000 BBL on previous wells.

Avoided kick/loss cycles & Improved ROP.
Case History 4 – South America

Petrobras Colombia Limited,

**MPD Added Value**

- No Loss of Circulation
- Significant cost savings
**Case History 5 – Canada**

Northeastern British Columbia,

**MPD Added Value**
Reduced AFE by approximately 19% (saving Can$ 2 Million).

Drilling efficiency was improved by lowering the mud weight and doubling the ROP.

Considered MPD techniques to increase drilling effectiveness in this field.
MPD application in Vietnam

BIEN DONG POC HPHT Gas Condensate Development
BLOCK 05-2 & 05-3 Offshore - Vietnam

Why MPD on this project?

✓ Narrow margin of PP/FG pressure in both fields.

✓ Early kick detection & control.

✓ Better well control in HPHT wells.

✓ Drill wells to target depth and eliminate additional casing string.

✓ Providing CBHP during static and dynamic conditions which mitigates stress caging (SC).
Project Overview

Phase-1: total sixteen (16) wells:
- 6 wells in block 05-3 (Moc Tinh)
- 10 wells in block 05-2 (Hai Thach)

Contract status: signed for 4.5 years + potential extension.
Conclusions

The challenging hydraulics of the world’s remaining prospects indicate MPD will evolve to become a key enabling technology.

Managed Pressure Drilling technology is increasingly being applied in reservoirs that are difficult to drill conventionally (Un-drillable), deep water and High Pressure, High Temperature (HPHT) wells to access HC reserves, enhance operational safety and efficiency.

All “first adopters” of MPD offshore plan future wells.
Conclusions (cont’d)

Managed Pressure Drilling can reduce well costs as a result of;

- Reduced number of casings = Smaller casings = smaller rig
- Less consumables (mud and cement)
- Less materials and logistics cost

Additional Benefits of MPD:

- Faster drilling
- Reduced formation damage
- Improved productivity = improved recovery
- Reduced environmental impact
Wrap-Up

Proper candidate screening is a deliberate process, and is a critical step in the design of a successful ADT operation.

Detailed economic analysis is an important step to determine the benefit that MPD could provide compared to competing conventional drilling & completion technologies.

Poor screening and planning results in an over-enthusiastic misapplication of the technology, and possibly failure.

Proper Project management, engineering and execution is a key factor for a successful MPD operation.
Your Feedback is Important

Enter your section in the DL Evaluation Contest by completing the evaluation form for this presentation:

Click on: Section Evaluation
Hani Qutob
Reservoir Engineering & UBD-MPD Advisor
Senergy GB Limited
Dir: +971 4 387 3022
BB: +971 5 0622 4513
M: +971 5 0657 7328
F: +971 2 667 0408
E: Hani.Qutob@senergyworld.com
W: www.senergyworld.com
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