Well Control Considerations of MPD on Deepwater Rigs

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MPD: Mitigating Well Control Risks, Directly & Indirectly

• Narrow, shifting and/or relatively unknown mud weight windows
• Kick-loss scenarios
• Differential sticking, risk of twist-off & side tracks
• Ballooning phenomenon
• Excessive casing stings, each a potential leak path
• Extra days to TD and time for something else to go wrong
• Temptations to take short cuts to cut costs later in the drilling program
• Techniques have been evolving on land drilling programs for decades.

• Most US land programs drill at least one section with a RCD + choke for Air/mist/foam Drilling, UBD or MPD – as measured by RCD Rentals
  • US land rig count – 1,860
  • ~1,000 RCD’s on drilling locations (all providers)
  • …and considering no location will rent anyone’s RCD for the total number of days the rig is counted as working.

• About 40% are drilling with mud and not inviting the well to flow…
  • Usually not thought of as “MPD”, per se.
  • “just the right way to deal with”
    • Loss circulation, differential sticking, risk of twist-off
    • Kick/loss scenarios in narrow and/or shifting drilling margins
    • Divert fast kicks from beneath rig floor
    • Lack of confidence in Pp-Fp estimates”
    • “Front office expects me to be at ____ depth by morning with the mud they left me to drill with tonight…probably have to hold backpressure on connections for a few stands…”
On land “its just the way you drill”, but…

- If you’re drilling with an essentially incompressible fluid and not inviting the well to flow in the process…

- And you find that the well wants to flow during connections, and holding backpressure on connections so you can keep drilling a few more stands with the mud in the hole…maybe get to the next casing set point,

- Or if you’re drilling with a closed-loop system and injecting nitrogen to get mud light enough to avoid losses in depleted zones,

- Or if you’re drilling with a RCD to close returns immediately under the rig floor just for HSE reasons; operator/contractor policy, on Federal Lands, some municipalities, or insurance underwriter required…

…You are practicing some form of MPD!
Offshore – MPD was about well control …from the beginning…


• Coined the term – Managed Pressure Drilling (MPD).

• Spoke to using UBD equipment to drill overbalanced with more precise management of the wellbore pressure profile.

• NOT inviting the well to flow in the process…

• …but for mitigating risks to the century-old conventional-wisdom of the hydraulics of drilling.

• Many of which have potential to be root cause or a contributor to loss of well control.
4 variations are practiced on floaters

- **Constant Bottom Hole Pressure (CBHP)** for drilling in narrow/shifting or relatively unknown safe mud weight windows.

- **Pressurized Mud Cap Drilling (PMCD)** for drilling in severe to total loss zones.

- **Returns Flow Control (RFC)** for HSE only; early kick-loss detection, riser gas handling, reduce frequency of false positive kick alarms, control wellbore breathing, positive diversion of returns, etc.

- **Dual Gradient Drilling (DGD)** for removing some or all of the hydrostatic pressure otherwise created by a tall column of annulus returns in the marine riser.
Deepwater closed-loop system for CBHP, PMCD & RFC-HSE
CBHP MPD mitigates…

Conventional circulation within tight windows

\[ AFP = \text{Circulating Annular Friction Pressure} \]

Frequency of False Positive Kick Alarms

Typical Kick Volume Detectability

Floating Rig with significant heave

Land Rig

Closed-loop MPD

Pressure

AFP

< 1 bbl.

~ 5 bbl.

~ 20 bbl.
CBHP MPD – primary well control benefits

- Avoid kick-loss scenarios
- Early kick-loss detection
- Frequent dynamic FIT’s & LOT’s
- Quantify ballooning
- Deeper open holes – fewer potential leak paths for life
- Riser gas mitigation
- Closed-loop cementing
- Less time to TD
- Safely drill the “un-drillable”
DGD removes some or all riser mud column pressure

- Pressure profile more closely matches that of ‘mother nature’
- Enables drilling with heavier mud
- Simplifies well construction
- TD with larger hole
- Like CBHP & PMCD, DGD may enable drilling the “un-drillable”
Methods of achieving DG

• **Positive Displacement Mud-Lift Pumps** near mud-line, subsea rotating device (SRD) & riser filled w/seawater. (Chevron DGD).

• **Controlled Mud Level** with Disc-Flow type pumps alongside riser at some depth, vacated riser above, no SRD. (AGR EC-Drill)

• **Mud Dilution** with concentric casing (Transocean)
Applicable to all variations

• Commitment by stakeholders method chosen will address the target drilling challenges.

• MPD-specific equipment meets applicable industry standards and proven fit-for-purpose. i.e., RCD complies with API 16RCD.

• Requires considerable pre-planning; hydraulic flow modeling/simulation, hazId/HazOp, contingency plans.

• Extensive crew orientation & training.

• Extra service providers aboard.

• Pre-approval by regulatory.

• Clear understanding by all involved – when to revert to conventional well control procedures.

• *Note: Controlled Mud Level DGD requires specialized procedures to circulate out an influx & may not lift kill weight mud.
Conclusion

• MPD has always been about ‘control of the well.

• Mitigating the types of deepwater drilling hazards which have played roles in a well control incident of some consequence.

• Four variations, each applicable to address different types of drilling challenges.

• With hundreds of deepwater applications to date in other oceans & no reportable well control incident ...MPD has a bright future in the Gulf of Mexico.

• After all, its root concepts were originally developed with GoM drilling challenges in mind.
Questions?

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