Weatherford®

Controlled Pressure Drilling® and Testing Services

More Productive Drilling™

Application Answers:
Pressurized Mud-Cap Drilling

Well Design to Energize Assets

Challenge

Mitigate extreme losses and reduce associated nonproductive time (NPT) when drilling highly depleted zones or formations containing large voids, such as caverns. Avoid well-control issues resulting from difficulty in maintaining a fluid column as a primary barrier.

Constraints

Losses must be mitigated until a permanent form of isolation—usually casing—can be installed. Conventional lost-circulation control techniques do not work, and/or fluid and lost-circulation material (LCM) costs prohibit acceptability of high loss rates.

Pressurized mud-cap drilling enables high ROP, less flat time and lower-cost drilling in extreme-loss situations.

Answer

Pressurized mud-cap drilling (PMCD), one of a number of discrete variants of managed pressure drilling (MPD), allows drilling to continue without incurring the large drilling mud costs normally associated with losses, while also reducing well-control risk. What would otherwise be a negative in conventional drilling—extreme losses—is transformed into a positive—reduced mud costs, better well control, less NPT and faster rate of penetration (ROP).

A rotating control device (RCD) is installed above the conventional blowout preventer (BOP), and a column of heavyweight mud is pumped down the backside of the drillstring. The mud, in combination with annulus pressure control facilitated by the RCD, serves as an annular barrier in both the drilling and tripping phases. Drilling into the hazard zone continues, using a lighter, non-damaging fluid such as water. Losses of this low-cost sacrificial drilling fluid are simply accepted. The mud cap, augmented by annulus backpressure applied at surface, prevents circulation of mud and cuttings back to the rig. Cuttings are injected into the hazard zone or a weak thief zone above it.

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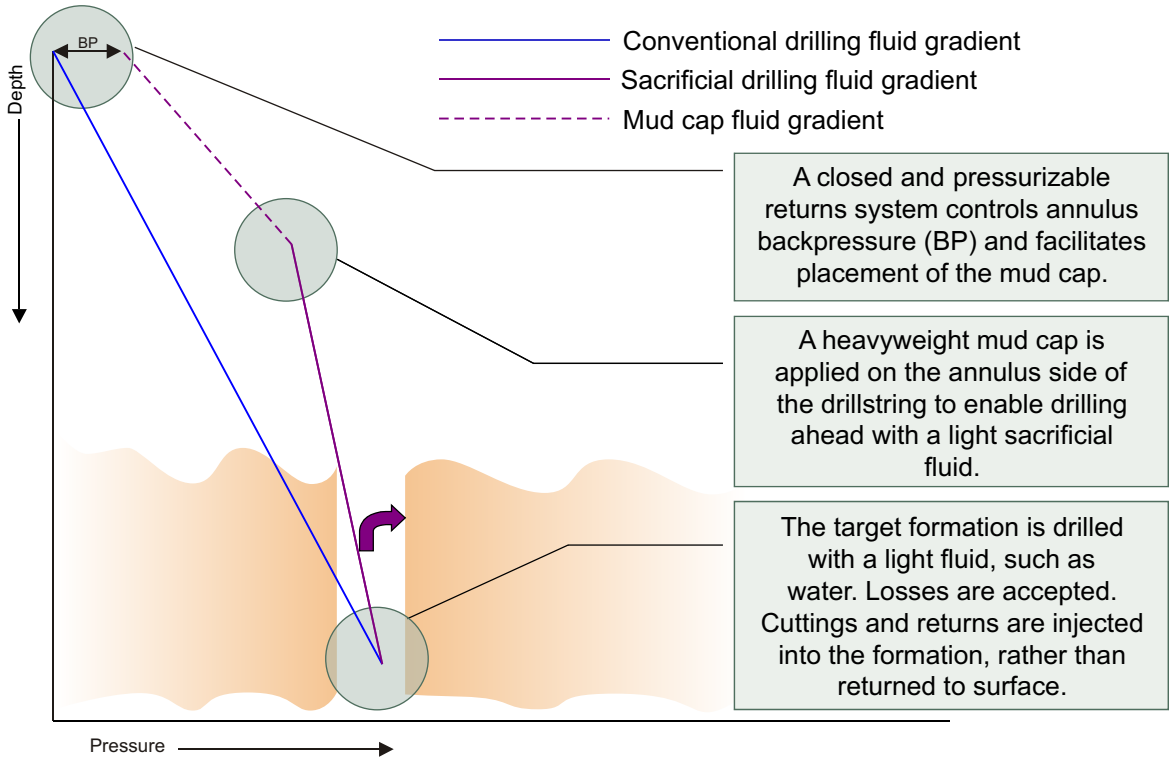

Pressure-versus-depth illustration of PMCD. A high-density fluid "mud cap" is placed on the backside of the drillstring. An RCD and choke enable control of surface backpressure while drilling ahead with a lighter, less costly fluid. Losses into the hazard zone are accepted.

Features, Advantages and Benefits

- The introduction of a pressurized mud cap allows you to drill hazard zones with a lower-cost sacrificial drilling fluid, such as water.
- Losses of the low-cost sacrificial fluid are simply accepted as better than the conventional alternative of losing significant volumes of high-cost heavyweight mud.
- Depending on the characteristics of the hazard zone, drill cuttings can simply be injected into that zone, eliminating the need to clean and dispose of cuttings at surface. A negative wellbore characteristic is now a positive.
- The injection of cuttings to the hazard zone may eventually plug the zone and enhance wellbore stability, mitigating yet another drilling hazard.
- A lighter drilling fluid is used to drill ahead, meaning that ROP increases, rig time is saved, costly heavyweight mud is not lost, differential sticking is avoided and overall well costs are reduced.

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- Despite the existence of near-total losses, well control is maintained by incorporating an RCD above the BOP. In concert with an additional choke, this advantage enables proactive management of annulus backpressure.
- The inclusion of drillstring floats above the bottomhole assembly enables connection makeup and breakout while maintaining applied annulus backpressure and preventing U-tubing of the annulus fluid.
- Depending on reservoir characteristics, a less damaging drilling fluid can potentially be used to help optimize ultimate well productivity.
- The conventional alternative of committing a casing string to isolate the extreme loss zone is not required. PMCD means casing shoes can be set deeper and well total depth (TD) is reached with a larger hole size.

Operational Outline

- Performing a PMCD operation for the first time may appear a daunting prospect, but it is easier than you may think. Weatherford will provide advice and guidance—in the form of expert operations drilling engineering support—to assist you in well planning and programming as well as rig-site execution.
- Weatherford assists with hydraulic flow modeling during the planning phase of a PMCD hole section. Modeling determines the mud-cap column length and required density as well as the range of applied annulus surface pressure to maintain a stable mud-cap height.
- PMCD rig-ups will vary, depending on application specifics, rig type and operating environment; however, the essential system components remain the same—a suitably specified RCD, an additional choke manifold, a dedicated mud-cap pump and drillstring floats.
- When PMCD is applied, these components are rigged up and tested before drilling of the expected hazard zone commences. Once the components are rigged up, the switch to PMCD mode can be made quickly should an unexpected extreme-loss situation arise.
- Optional PMCD system enhancements may include: wireline-retrievable drillstring floats, which remove the need to trip to service floats; a downhole deployment valve (DDV) to accelerate and increase the safety of tripping operations; and pressure while drilling (PWD) and DataPro™ software to enhance real-time downhole- and surface-pressure management.
- In many situations, the rig's readily available kill fluid is the best option for the mud-cap fluid.
- Standard drilling practices are adopted, with the only changes relating to proactive annulus backpressure management, operation with two fluid types (mud-cap and sacrificial fluids), and minor modification of drillstring makeup and breakout procedures.
- When PMCD is used, annulus backpressure is adjusted to ensure that mud and cuttings are injected rather than returned to surface. Continuous monitoring of fluid circulation-system pressures (surface and downhole) informs these control adjustments.

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MPD Defined

Managed pressure drilling is an advanced form of primary well control that uses a closed and pressurizable fluid system to more precisely control wellbore pressure.

The benefit MPD produces is drilling what may otherwise be economically undrillable prospects so that total recoverable assets can be increased at an economically viable cost. The adoption of MPD techniques is usually “drillability” driven when there is a need to mitigate drilling hazards and maximize drilling AFE cost certainty. The intent in applying MPD is to optimize the drilling process by decreasing nonproductive time (NPT) and mitigating drilling hazards. The primary distinction between MPD and the other related techniques of performance drilling and underbalanced reservoir drilling practiced by Weatherford is that influx of hydrocarbon-bearing formation fluids is **not** invited during the MPD drilling process.

Reactive MPD. The technique is effectively on “standby” as an enhanced form of passive well control to help manage unexpected downhole pressures.

Proactive MPD. The technique is used to its maximum effectiveness to mitigate a wide range of drilling hazards. Proactive MPD radically reduces drilling NPT by enabling fundamental changes to fluid, casing and openhole programs.

The four primary variants of proactive MPD enable deeper openhole sections; reduce the number of casing strings, NPT and mud-density changes needed to reach total depth objectives; and enhance well control.

Ask Weatherford to help you assess your MPD opportunity and tailor an MPD variant to suit your specific drilling hazard mitigation needs.

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