Blending technologies: MPD, casing drilling can eliminate intermediate casing string

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ABSTRACT

PREMATURE SETTING OF intermediate casing and drilling liners are a source of cost overruns for today's drillers. A technology blend is coming into focus that may increase the depth at which casing is set and perhaps eliminate one or more casing strings from a project. The blend combines Managed Pressure Drilling (MPD) with casing drilling to widen the window of pore pressure ranges that can be addressed in an open-hole section.

The technique, called Managed Pressure Casing Drilling (MPCD), may be effective for drilling through formations where conventional methods are not practical or have previously failed. Despite the engineering challenges, MPCD has the potential to reduce wellhead costs, pipe costs and decrease time to run and cement the intermediate casing string and rig down/up the blowout preventer stack. Downsizing the hole can also potentially decrease mud and cement costs.

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INTRODUCTION

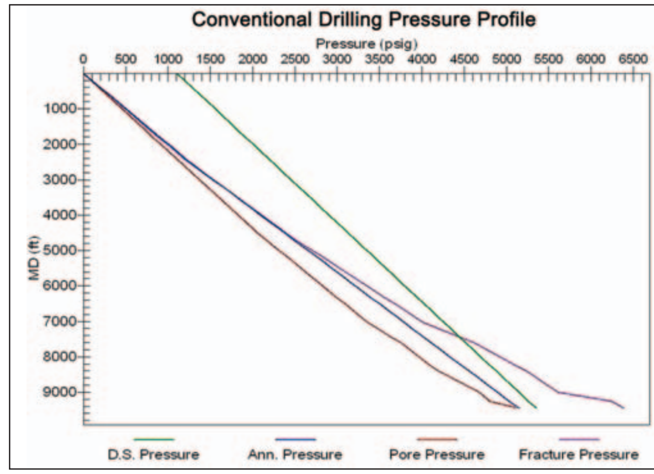
Historically, the length of vertical open hole drilled below surface pipe has been determined by the formation integrity test (FIT) at the surface shoe and the mudweight (MW) density required to overcome the formation. Pore pressure (PP) has been addressed with an overbalanced mudweight (MW), which controls influx but effectively limits the window of pressure management.

The depth at which the MW approaches the FIT of the surface shoe with some predetermined safety factor (kick tolerance) is the depth at which the next casing shoe is set. Sometimes an intermediate casing string is required prior to the depth of maximum MW due to hole instability, lost circulation (LC) or other drilling problems.

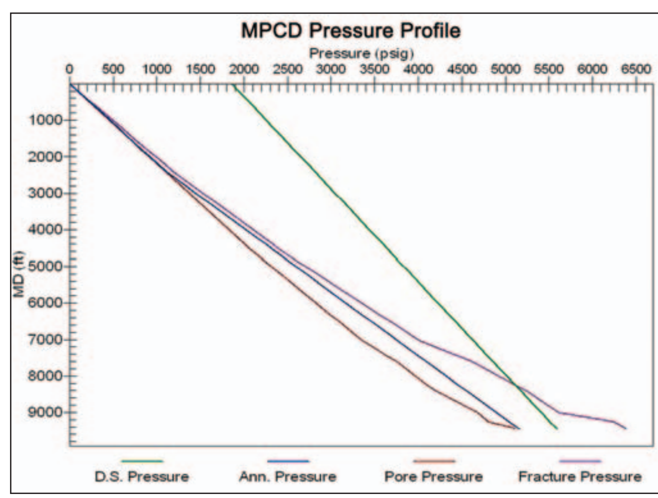
As global exploration deepens, increasingly narrow pore pressure-frac gradient margins may be encountered, often with extreme pressure depletion in the wellbore. Drilling conventionally into formations where extremely variable pore pressures are open to the wellbore presents a high risk of costly formation instability and associated well control problems. Risks include hole collapse, LC, stuck pipe, underground blowouts and loss of hole.

If PP exhibited in the primary target is greater than the pressure at a shallower depth, and casing is not properly set and tested, the weaker rock zone above may break down. When this happens, drillers often encounter formation cross-flow, leading to increased flow of gas, oil and water from the high-pressured permeable zone into the low-pressured, weak rock zone.

Such well-control events can be detrimental to the well's productivity. Usually, drillers must dynamically kill the well, if possible, prior to pumping cement to achieve abandonment.



The Pressure Profile 1 shows a well drilled conventionally. A dense mudweight is required to balance the bottomhole pressure but causes the wellbore pressure uphole to exceed the frac gradient. Drillers typically set intermediate casing string to avoid hole collapse, lost circulation or loss of hole. These profiles were created using the Hydraulic UnderBalanced Simulator developed by Signa Engineering Corp.



The Pressure Profile 2 graph illustrates an actual MPCD well. The inherently smaller annulus in casing drilling allowed a greater frictional pressure gradient along the lower section of the wellbore. Using managed pressure drilling, a less-dense mudweight was used and the circulation rate was designed to balance the bottomhole pressure while keeping the uphole wellbore pressure below frac gradient. This technology blend allowed drillers to drill ahead and eliminate an intermediate casing string.

MANAGED PRESSURE DRILLING

In MPD, the driller seeks to stay slightly above or "at-balance" to the downhole pore pressure, or as close to near-balance as possible during the entire section of problem hole, both when drilling and during connections. Precise control of downhole pressure allows the driller to drill within the window between PP and fracture gradient (FG) without setting casing prematurely or damaging the formation with excessive mudweight.

Although several variations exist, successful application of MPD is typically accomplished through 3 key components: a closed and pressurizable circulating system with associated MPD equipment, an optimal hydraulics plan designed before drilling spud, and skilled engineers familiar with the concept.

The closed system enables the driller to safely drill into horizons that can flow into the wellbore since the mud returns system is not directly open to the atmosphere. The system includes necessary MPD surface equipment (and, in some cases, downhole equipment) to impose surface backpressure on the wellbore and control abnormally high or low pressures in the formation without using the conventional standard of "weighting up" every time an influx is taken. Annular backpressure can be controlled at the surface through a Flow Choke Manifold to precisely maintain the downhole pressure regime and avoid blowouts. Other vital equipment includes a Rotating Control Device placed appropriately above the Blowout Preventer stack, a flare line and an adequate mud-gas separator.

CASING DRILLING

Casing drilling allows operators to drill and case the well simultaneously using standard oilfield casing that is permanently installed in the well. The casing provides hydraulic and mechanical energy to the drilling assembly in lieu of conventional drillpipe. Typically, drilling fluid is circulated down the casing and back up the annulus similar to conventional drilling.

ConocoPhillips has used **Tesco**'s CASING DRILLING™ system extensively in an effort to make drilling faster, safer and more cost efficient. In 2002, ConocoPhillips began using Tesco's system to drill development wells in the Lobo Field of South Texas and has drilled over 120 wells with the system.

Drillers had encountered numerous troubles in the intermediate and production sections of wells when drilling conventionally. By utilizing Casing Drilling, downhole problems and drilling time were significantly reduced.

By eliminating drillstring tripping and all the problems associated with trips, casing drilling can speed up the drilling process by 20% to 30% and allow savings on operating costs and capital investment. Several application basics of Casing Drilling also enable MPD to be applied more effectively.

APPLYING THE TECHNOLOGY BLEND

The MPCD blend combines the most powerful and efficient aspects of MPD and casing drilling to reduce weaknesses the techniques sometimes exhibit when used independently. In essence, the sum is greater than its parts – parts already remarkable, since individually they are considered to be on the forefront of technology.

Conventional casing drilling technology may eliminate trips to run casing, but many of the conventional drilling problems still remain, and in fact may become aggravated. Lost circulation, stuck pipe and formation ballooning are all aggravated by the small annulus and relatively high ECD at required drilling pump rates.

Similarly, MPD with drillpipe still suffers from many of the same problems that plague conventional drilling techniques. Depending on hole depth, mudweight and mud rheology, the large annulus between drillpipe and hole diameter may diminish the ability of the mud pumps to generate sufficient ECD to control pore pressure in the open hole. Thus the operation becomes more dependent on mudweight and its effect on hydrostatic column.

Conversely, the MPCD blend represents a "one plus one equals three" situation. The reduced annulus of casing drilling allows the mud density to be decreased such that a greater range of control in the open hole is attributed to other MPD parameters. Mud rheology, hole geometry, surface backpressure and pump rate can be effectively manipulated to instantaneously extend and control the pressure profile in the open hole. Consequently, casing seats may be extended or eliminated altogether.

Currently, MPCD appears best suited to soft rock, onshore, high-cost drilling areas and marginal prospects. However, it could move offshore and eventually into deepwater.

For successful MPCD, the driller must determine the location and extent of permeable and impermeable rock. The failure mechanics of exposed rock must be addressed to avoid borehole collapse. The pore pressure of permeable rock must be addressed according to the intent of the drilling operation. Influx from permeable rock must be controlled with a balanced or slightly overbalanced equivalent hydrostatic column.

Depending on rock strength and collapse issues, the pressure margin may be adjusted at the bit to allow for less overbalanced stress on a weak rock section in the upper part of the exposed bore hole. This adjustment can be affected by appropriate MPD parameters. Managing pressure in the upper part or mechanically weaker part of an exposed hole section may be the most important aspect of extending or eliminating a casing seat.

A good MPCD candidate is determined by the pore pressure ranges and rock strength that have been exposed below the last casing shoe in the open-hole section, and whether that variance in pressure can be sustained. The pore pressure profile in a given open hole section must be determined as closely as possible prior to drilling. This may be accomplished by a detailed pore pressure analysis using log data, seismic data, RFT pressures and initial production pressures. Leak off tests and formation integrity tests may be used to verify the fracture gradient profile near casing seats. A robust computer modeling software is also essential to a precise downhole hydraulics plan.

MPCD has proven ideal for use in tight gas sands and naturally fractured formations and for areas where the pressure regime in a vertical hole changes significantly with depth requiring multiple casing strings. However, as the blend is still in its infancy, those considering the technology cannot arbitrarily exclude or include candidates. In many cases, such as when drilling highly fractured gas formations with a high Productivity Index, considerations must be given to increased formation influx rates and decreased latitude between kicks and losses.

Currently, MPCD appears best suited to soft rock, onshore, high-cost drilling areas and marginal prospects. However, it could move offshore and eventually into deepwater.

SUMMARY

The MPCD technology blend may be used to increase the window of pressure management when drillers expect to encounter weak rock or depleted pressure zones. Increasing the window of pressure management in an exposed section of hole may be the difference in attaining total depth in a very deep well or finishing a well with 3 casing strings instead of 4. The potential for cost savings in economically justified wells is as impressive as the ability to drill wells that otherwise would not be chosen for investment of drilling capital.

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