Blending technologies can eliminate casing strings

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DURING RECENT ATTEMPTS to lower drilling costs in several fields, a practical blend of several oilfield technologies was developed that may set a substantial, cost-effective trend in the evolution of drilling techniques. The process involves combining underbalanced drilling (UBD) with casing drilling (CD), while simultaneously using managed pressure (MP) techniques to widen the window of pore pressure ranges that can be addressed in an open hole section.

The inventive method, dubbed UBCD-MP, is especially exciting because it has the potential to eliminate the need for one or more intermediate casing strings. This is a major milestone in the drilling process that could dramatically reduce cost, especially in areas where casing strings were historically seen not as an option, but as a costly necessity.

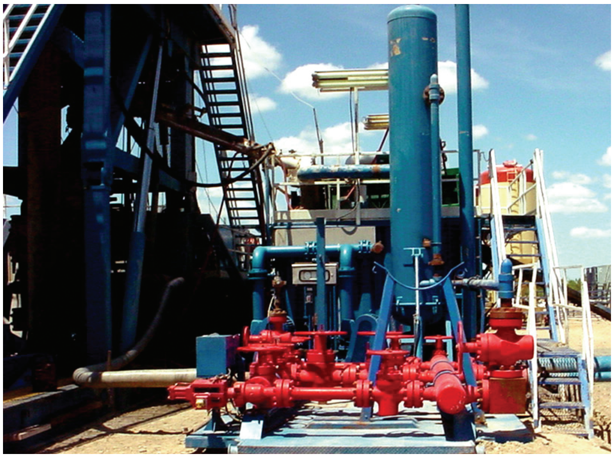
The UBCD-MP blend draws advantages from several techniques to create a unique, dynamic application that can be designed in the field for maximum efficiency. By harnessing the latest technology to analyze data, the technique has proven effective for drilling through formations where conventional methods are not practical, or have failed in the past.

The blend synergistically combines the most powerful and efficient aspects of UBD, CD and MP to reduce weaknesses the techniques 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.

Despite the engineering challenges involved, the economic benefits have proven to be worthwhile. Cost savings can range from 40-60%, including wellhead cost savings, reduced pipe costs (no intermediate casing string) and the time saved to run and cement the intermediate casing string and rig down/up blowout preventer stack. Mud and cement costs also are potentially decreased by downsizing the hole while drilling a longer section.

CASING DRILLING

Casing drilling was developed through a joint effort between **ConocoPhillips** and **Tesco** in an effort to make drilling faster, safer and more cost efficient. Over the last five years, $50 million has been spent in the evolution of casing drilling from an experimental process into a proven technique.



The rig choke manifold may be adequate for managed pressure drilling, but for underbalanced drilling, a separate flow choke manifold is desirable.

The major benefit of CD is the avoidance of trips during drilling. The technique 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 in CD, drilling fluid is circulated down the casing and back up the annulus similar to conventional drilling. The casing can be rotated from the surface, and with one system, a bottom hole assembly (BHA) is latched to the bottom joint of casing and run/retrieved via wireline, making bottom hole retrieval and directional drilling possible.

By eliminating drillstring tripping, and all the problems associated with trips, CD can speed up the drilling process by 20-30% and allow savings on operating costs and capital investment. The technique also improves safety because CD eliminates drill pipe handling. The small annulus characteristic of casing drilling allows for drilling a given section of hole with less mud weight than with conventional drillpipe. The increased annular friction, or Equivalent Circulating Density (ECD), developed at typical circulation rates replaces some mud weight to drill a section of hole when trips are required.

There are two main technologies for CD applications. The first employs a BHA comprised of a positive displacement motor (PDM), drill bit and a hole opener. The assembly is latched to the first joint of casing. The hole is drilled with this assembly while the casing is lowered into the hole, either in a static or rotating mode. Upon reaching total depth (TD), the latch-on bottom-hole assembly is recovered with a wireline conveyed retrieval tool. A valve system is run and installed before cementing occurs.

The second technology utilizes only casing to transmit rotary torque and weight to the drill bit. A drill bit and valve assembly is made up and run with the first joint of casing. The casing string is rotated during drilling, typically with a spear assembly that provides rotation to the casing. Upon reaching TD, there is no need for an additional trip and the casing can be cemented easily.

UNDERBALANCED DRILLING

Underbalanced drilling offers advantages in reduced drilling problems, reduced formation damage and improved penetration rate. As familiarity with these benefits becomes more widespread, UBD is quickly becoming a standard application for drillers to consider rather than an obscure option.

Much of its popularity has stemmed from an intensified interest by oil and gas companies in improving reservoir recovery and maximizing project economics. The process involves drilling into any formation where the pressure exerted by the drilling fluid is less than the formation pressure. Consequently, the formation pressure will cause permeable zones to flow if other conditions allow flow at the surface. An underbalanced condition may be identified by formation influx or annular pressure recorded at the surface. Some circulating media used for underbalanced operations include gas, air, foam, clear fluids, oil or weighted muds.

Other advantages of UBD are minimizing lost circulation, real-time formation productivity evaluation, reduced cost due to increased ROP, reduced drilling problems, improved bit life and lower mud costs.

Allowing a Class 4 or 5 well to flow with drill pipe out of the hole may become hazardous to the drilling crews working the job. Re-entering a live well with a drilling assembly may be difficult, depending upon the magnitude of annular pressure at the surface. It is not prudent to incur such a situation unless a viable plan has been conceived to contain surface pressures within a limit that allows reentry with the drilling assembly. Consequently, UBD operations are most vulnerable during drill pipe trips.

It is difficult to maintain a state of UB during trips due to vertical migration of hydrocarbons. Managing a live well during UB operations is dynamic in every aspect. Conditions rarely stabilize and quite often the driller finds himself dealing with changing conditions that steadily worsen. Efficient management of UB conditions is, among other things, a matter of timing.

MANAGED PRESSURE DRILLING

Managed pressure drilling attempts to precisely control the annular fluid pressure profile within a wellbore. The process allows the driller to deal with pore pressure variations in the wellbore and has proven effective in extending casing seats and avoiding problems resulting from excessive mud weight. The pore pressure profile in a given open hole section must be determined as closely as possible prior to drilling the section. This may be accomplished by a detailed pore pressure analysis using log data, seismic data, RFT pressures and virgin production pressures. Leak off tests and formation integrity tests may be used to verify the fracture gradient profile near casing seats.

Consequently, this need for detailed pore pressure knowledge may exclude exploratory wells from managed pressure applications. One possible exception is deepwater applications.wheremany are exploratory in nature.

The relative hydrostatic "margin" between pore pressure and fracture gradient in the normal pressured horizons of a deepwater well may be small. Many deepwater types of sediment will simply not withstand the column of mud required to return the cuttings to the surface of the sea. Break down of a deepwater wellbore can result in severe loss of circulation, kicks from exposed permeable zones, stuck pipe and associated drilling down time.

Managed pressure techniques endeavor to use a mud weight that is "balanced" to the greatest "permeable zone" pore pressure required in the exposed well bore.

In the UBCD-MP blend, specifically the applications that have recently proven effective for Signa Engineering, a mid-range mud weight can be used between the lowest and highest pore pressures in an exposed wellbore. One must first determine the location and extent of permeable and impermeable rock. The failure mechanics of impermeable 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. In managed pressure drilling, influx from permeable rock must be controlled with a balanced or slightly overbalanced equivalent hydrostatic column. Using this technique, onshore operations have been successful at extending or eliminating casing seats, avoiding mud weight related drilling problems and minimizing drilling flat time.

PROBLEMS FOR PROFITS

As mentioned, the UBCD-MP blend extracts the best qualities from the trio of aforementioned unconventional methods to create a unique process that can remove typical vulnerabilities when UBD, CD and MP are used independently. For instance, the most vulnerable time relative to cost and safety for operators drilling underbalanced is during trips, so obviously a technique for drilling and isolating a wellbore without tripping can eliminate a major difficulty of UBD.

The higher annular friction while circulating with CD allows greater underbalanced margins with a given mud weight. In other words, the mud weight may be maintained at a density lower than typical with a drill pipe job.

Additional density would then be simulated with pump rate and associated ECD to satisfy the needs of the wellbore at the bit. If pore pressure increases with depth, the formations above the bit may be effectively overbalanced by the same mud weight that cause an underbalanced environment at the bit.

Depending upon rock strength and collapse issues, the UB margin can 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 either mud weight adjustments or by changing the pump rate. It is often simplest to change the pump rate. 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.

The UBCD-MP blend is not applicable in every formation. In many cases, such as when drilling highly fractured gas formations with a high productivity index, special considerations must be given to increased formation influx rates and decreased latitude between kicks and losses.

This blend of technology sets has proven ideal for use in tight gas sands and similar formations, and for areas where the pressure regime in a vertical hole changes significantly with depth. However, as the blend is still in its infancy, those considering the technology cannot arbitrarily exclude (or include) applications that could possibly benefit.

APPLYING TECHNOLOGY

As with most unconventional methods, determining whether wells are good candidates for UBCD-MP varies with each scenario. Application of this technology is well specific and no all-inclusive formula or specifications can be used as a diagram to insure the technique is a success.

However, thoughtful planning and management in several applications has shown the technology blend is a powerful new weapon in the expanding arsenal that drilling engineers can use to tackle difficult drilling situations and lower operational risk.

Drilling dollars are budgeted according to economic parameters that include the risk of exposing a producing formation to an acceptable conduit for production. Economic viability and risk assessment are often at odds in making this decision. Assigning risk to an economic program is often a personal assessment based on historical challenges in a given field or region, as well as the experience of the one making those assignments, and the level of confidence in the ability of new technology to reduce risk.

Assignment of risk may also be the result of personal and/or corporate motives and policies. Regardless of the method used for assignment of risk, often risk is the biggest issue in an economic evaluation of whether to drill a well or not.

Determining if a well is a good candidate centers directly around what pore pressure ranges and rock strengths have been exposed below the last casing shoe in the open-hole section, and whether or not that variance in pressure can be sustained. A rigorous hydraulic model is also required to guide the drilling engineer through the UBCD-MP process.

The technique can be hazardous without a complete understanding of the formation makeup. By utilizing such a model, operators looking to utilize the UBCD-MP blend can effectively forecast the significant economic benefits by modeling the entire downhole procedure from start to completion. The UBCD-MP blend has the potential to significantly reduce operators' costs when applied correctly and managed properly with software that can simulate all areas of a wellbore. Software that simply monitors the surface and bottom-hole pressures is not acceptable.

As stated, in conventional drilling, pore pressures in the exposed permeable rock must be addressed with a higher or "overbalanced" mud weight, thereby limiting the window of pressure management. The existence of a weak rock or depleted pressure zone may further complicate the driller's ability to achieve the next casing seat. The UBCD-MP technology blend may be used to increase the window of pressure management in such cases.

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 three casing strings instead of four.

The potential for cost savings in economically justified wells is as impressive as the newfound ability to drill wells that otherwise would not be chosen for investment of drilling capital. ■