Well Construction Technologies for Prediction of Complications and Risk Mitigation

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ABSTRACT

Managed Pressure drilling (MPD). Drilling-related issues such as excessive mud cost, differentially stuck pipe and resulting well control situations associated with loss circulation issues contributed to define the necessity for a more efficient drilling technology. Drilling into narrow downhole pressure environments with the kick-loss scenario opportunities is another issue to be resolved. Drilling-related flat time further indicate a necessity for a technology that enables better management of downhole pressure. A conventional mud returns system is an open-to-the atmosphere system where returns mud flow away from the rig floor. The essence of MPD technology is the ability to drill ahead with closed and pressurizable mud returns. The Rotating Control Device (RCD) diverts pressurized mud returns to the choke manifold and its bearing and drill string seal assembly permits drilling ahead, tripping, etc. A primary objective of MPD is to address a long list of drilling-related problems or barriers to economic well construction. The contrast between conventional well control and well control in a closed loop system (CLD) is expressed with the help of a bow tie diagrams. In conventional well control, the operator attempts to identify, and design a well for these conditions considering casing, fluids, drilling practices, borehole cleaning parameters. Failure of these plans can lead to a well control event such as an influx. In a conventional circulating system that is open to the atmosphere, the options to prevent the consequence of the influx—a blowout are limited to mud remedies or closing the BOP.A CLD system adds new layers of options to both the prevention and mitigation sides of the diagram (Fig. 1). To prevent an influx, CLD adds real-time data for early event detection and identification. Annular pressure control provides a means of proactively managing pressure variations to prevent them from developing into a well control event. Continually monitoring and capturing data also provides feedback for updating pore pressure predictions and modeling future well designs practically online.

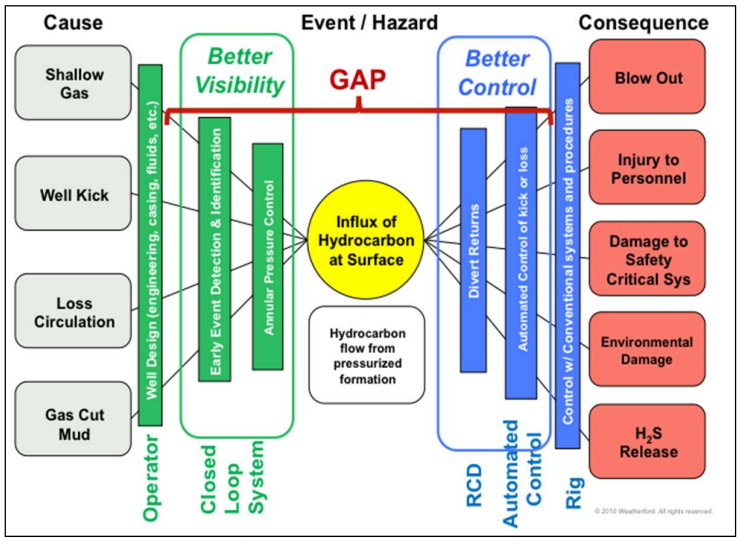

Fig. 1 Causes and consequences of an influx in the closed loop system

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Should an influx occur, a CLD system provides a greater degree of mitigation finesse ahead of closing BOP. The simple addition of an RCD greatly enhances crew and rig safety by diverting any returns away from the rig floor. Sour gas or a blowout, an RCD provides a fundamental improvement without any changes to conventional rig operations. Automated control of an influx using MPD methods applies annular backpressure to mitigate the influx and enable controlled circulation out of the wellbore. Both of these mitigation options enhance and supplement traditional control with methods that can be applied early, effectively and with much less disruption and cost than traditional means. Probabilistic risk analysis illustrates how these layers of well control planning and operational risk management affect performance. The initial driver for MPD is a need to navigate narrow-margin sections, characterized by a small window between pore pressure and fracture gradient. This makes it a natural candidate for HP/HT wells, where narrow margins is a common situation. When MPD is introduced to an HP/HT project, further application benefits can be found wherein MPD provides a solution to other traditional HP/HT challenges.

Drilling with casing (DwC). The DwC technique is used in many challenging wells to drill through troublesome sections such as depleted reservoirs, wells with severe wellbore instability, heavy losses etc. The principle of this technology is using casing string to drill the whole section, instead of drillstring. Two DwC options are available: (1) drilling without borehole navigation control with non-retrievable drillable bit; (2) drilling directional borehole with retrievable bottom-hole assembly (BHA). Main feature is the narrow gap between the borehole wall and casing (Fig. 2).

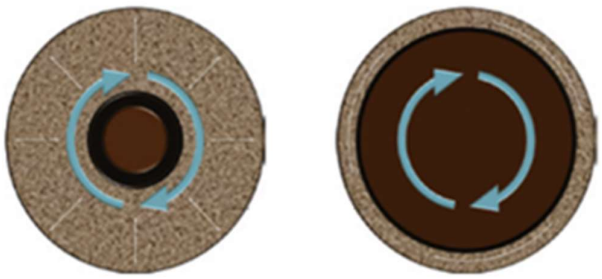

Fig. 2 Conventional (left) size of annulus compared to DwC situation

The string rotation with simultaneous mud flow in the annulus causes so-called smear/plastering effect providing borehole wall sealing and strengtheningby drilled rock cuttings or LCM.

Managed pressure casing drilling (MPCD). Last decade it has been proven through numerous field applications that both MPD and DwC bring value to drilling operations when used in the appropriate situations. MPD and CD/LD are complementary technologies, and can be combined, provided modifications are made to certain pieces of equipment to accommodate the closed loop and bigger diameter string. Using MPCD can be advantageous, provided careful candidate selection. In particular, the method seems well suited to drilling wells with very challenging pore pressure regimes, such as layered reservoirs with different pore pressures and heavily depleted reservoirs. This is supported by the case studies.

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