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Drilling Hazard Mitigation—Reducing Non-Productive Time by Application of Common Sense and High Value Well Construction Techniques

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Abstract

Mitigating drilling hazards—balancing drilling risks against the optimum well design while preparing for unplanned drilling events—has been a challenge to cost-effective well construction for decades. The pore pressure/formation fracture gradient balancing challenges mixed with the unexpected encounters with shallow flows, unstable formations, overpressure formations and depleted formations makes AFE (authorization for expenditures) goals dim.

Excessive use of loss circulation pills and traditional contingency liners drive well costs up and jeopardize reaching total depth (TD) with an effective completion. A drilling hazard remediation solution could be as simple as using that planned contingency liner or using drill-in casing to fight sloughing formations. However, the use of conventional solid expandable drilling liners can drive excessive risks into the well and even cause a costly sidetracking of the well.

Operators in the Gulf of Mexico, the North Sea and in Asia Pacific have been successfully using a set of proven well construction tools with a more “Fit for Purpose” application to mitigate drilling problems that have resulted in excessive non-productive time (NPT) during drilling operations. These systems are used only when necessary to mitigate the well challenge, allowing the well construction to continue while minimizing their NPT fighting these well problems.

This paper describes some of these “fit for problem” well construction tools and their applications in recent case histories.

Introduction – Drilling trouble zones

Drilling trouble zones typically consume 10 to 25% of a well’s AFE. Lost circulation zones, unstable formations, and pressure transitions events, to name a few, have typified the type of drilling challenges costing operators millions of dollars annually.

In technical drilling conferences dedicated exclusively to trouble zones, operators have reported on case histories that have shown the magnitude of these well construction costs¹. **Figure 1** illustrates problem incidents documented in a sampling of over 1,700 gas wells, drilled between 1993 and 2002 on the shelf in the Gulf of Mexico, representing approximately 24% of these wells’ NPT. The Dodson chart in **Figure 2** is a detailed representation of the data that documents the trouble incidents of these shelf gas wells in the Gulf of Mexico. While half of these “incidents” are not related to drilling trouble zones (i.e. weather, rig problems, etc.), about 12% of the total trouble time encountered was due to drilling trouble zones. The cost of these trouble zones to the operators drilling these wells was over 2.8 billion dollars in well construction costs.

While this data represents wells exclusively in the Gulf of Mexico, further research facilitated through interviews with operators on a global basis have resulted in 10 to 35% of well construction spent for drilling trouble zones.

Simplifying the causes of these drilling hazards reveals that most of these fall into the following categories:

- Wellbore Instability – 18% of the time spent addressing trouble zones
- Low Pressure Events – 22% of the time spent addressing trouble zones
- High Pressure Events – 12% of the time spent addressing trouble zones

These are illustrated in **Figure 3**.

Non-Productive Time

Reviewing drilling time versus depth plots on wells does not always represent the actual “total” time that is lost due to drilling trouble zones. Closer analysis of the events surrounding the “flat” time illustrated on these plots highlight that further lost time has occurred due to reduced drilling efficiencies. These, for example, occur when a low pressure or an over-pressured formation is first encountered while drilling but prior to flat time recorded on the plot. **Figure 4** illustrates where this “invisible” flat time occurs.

The resultant reduction in drilling efficiency, while beginning to “fight” these drilling hazards, causes the time versus depth plotted line to “flatten” or change slope as the rate of penetration (ROP) slows. Eventually the trouble zone temporarily “wins the fight” and drilling ceases. During this time the drilling personnel usually try a variety of “typical