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Successful Plug Placement with PlugAdvisor Modeling

Case study: Operator cuts kickoff plug jobs in Angola deepwater wells

CHALLENGE

Reduce the number of attempts needed to place kickoff plugs in highly deviated wellbores where slurries are pumped at underdisplacement volumes and mud contamination risk is high.

SOLUTION

Use PlugAdvisor* cementing plug placement design modeling to optimize displacement volumes, mud removal, and plug location; pump a viscous reactive pill to keep plug in position; and establish best practices to exploit experience of the operator and Schlumberger.

RESULTS

Set kickoff plugs on first attempts for Wells 1 and 2. Accurately predicted top of uncontaminated cement above Well 2 plug.

In the first application of the new process, engineers used PlugAdvisor software to optimize placement of cement plugs in Wells 1 and 2. The first attempts were successful on each, and the cement top of Well 2 was tagged at 2 m higher than the kickoff plug, as modeled.

Placement of deepwater kickoff plugs

The industry success rate for placement of cement plugs on first attempt using standard techniques is approximately 65%. Failure on the first try accounts for the most common form of NPT associated with cementing. For an operator in Angola, these challenges resulted in multiple job attempts. Sidetrack wells were increasingly being used in the exploration campaign to better delineate the deepwater reservoirs, and repeating operations to gain kickoff was expensive and time-consuming. In addition, predicting the top of the uncontaminated cement above the plugs was difficult. The operator wanted to reduce these uncertainties and their effect on deepwater authorizations for expenditure.

A team of Schlumberger and operator personnel charged with finding solutions determined that a key factor was the differential between the density of the wellbore fluid and that of the slurry, which was allowing the plug to fall through the mud column before it set. Other contributors were the small volumes of slurry being used and the inclinations common to the wellbores—sometimes 45° or higher. Slurry contamination by the synthetic oil-base mud in the fluid column was also a problem, preventing development of optimal mechanical properties in both the plug and the cement above it.

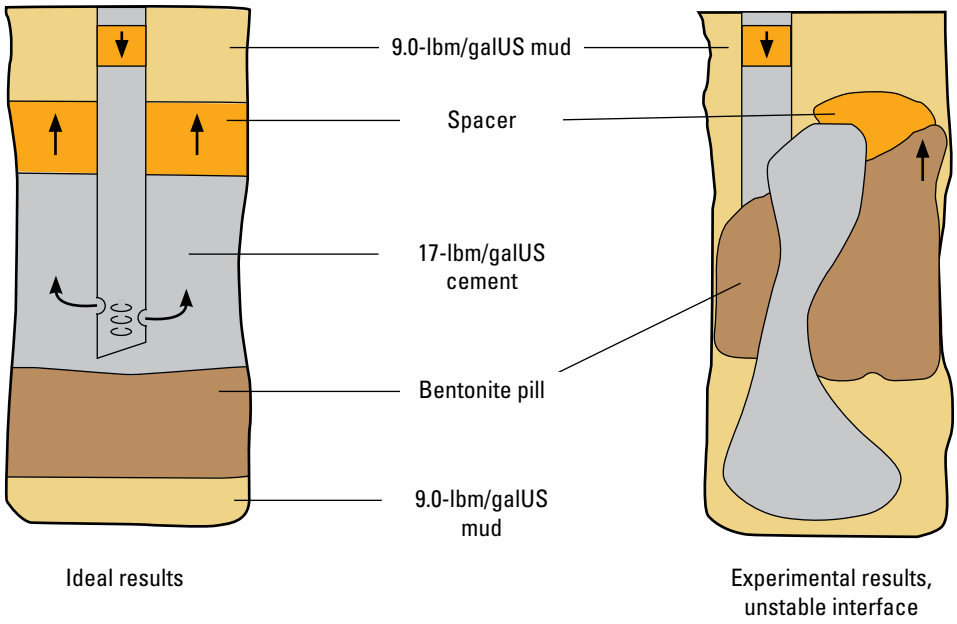

Diagram of a stable, ideal cement set (left) versus unsatisfactory results (right) of a dense cement placed above a lighter fluid.

Efficiencies through simulations and new processes

PlugAdvisor plug placement software was selected as a major part of the solution because of its unique ability to predict the top of the cement plug, the contamination level in the plug, and the end of the contaminated cement. With a holistic approach that covered the job from design through execution, the team proposed a solution for each challenge:

- Before the job, PlugAdvisor modeling would simulate the best location for the kickoff plug, the most effective process for mud removal, and the optimal underdisplacement volume. To limit interface movement when pulling out of the hole, underdisplacement had to be especially precise when a mixed string, such as drillpipe with stinger, was used to place the plug.
- To counteract the density difference in the slurry and wellbore fluid, a viscous reactive pill would be pumped to form the base of the cement plug. The team considered this step essential in highly deviated boreholes. The pill's viscosifier increases the fluid's ability to support solids, and the calcium in the cement—also present in some drilling fluids—reacts with the pill's silicate component to form a gel that prevents flow between the cement and the wellbore fluids.
- If the well's drilling fluid was oil-base mud, a viscous spacer would be placed before and after the pill to avoid slurry contamination.

Successful plug placement

In the first application of the new process, engineers used PlugAdvisor software to optimize placement of cement plugs in Wells 1 and 2. The first attempts were successful on each, and the cement top of Well 2 was tagged at 2 m higher than the kickoff plug, as modeled.

For the operator, PlugAdvisor software reduced the uncertainties associated with these operations and, therefore, the risk and expense in sidetracking their deepwater wells. Of the changes initiated in process and technologies, the team attributed the positive results to

- a holistic approach
- optimization of the underdisplacement
- reduction in slurry contamination
- application of lessons learned
- best practices of both the operator and Schlumberger.

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