Cement Spacer Technology Cures Lost Circulation and Improves CBL Results

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Summary

Many factors differentiate deep-water cementing operations from shallow-water cementing operations. Some of these factors are:

- Narrow window between frac and pore pressures - in many complicated cementing jobs, as the cement column begins to enter the annular space, the equivalent circulating density (ECD) approaches or exceeds the frac gradient. In these cases, low-density fluids are commonly used to prevent induced losses.
- Naturally fractured formations - technology is crucial to achieve a successful cementing job in lost circulation zones.
- Temperature - due to the high extension of water depth, low temperature gradients affect the behavior and properties of the fluids.
- Hydrostatic pressures - proportional to the water depth, the hydrostatic pressure exerted over the fluids in the well increases.

Lost circulation is a major problem often encountered while drilling and cementing wells. Lost circulation events can generate mud loss, hole instability, and an increase in rig time. All of these circumstances increase non-productive time (NPT) and overall rig costs.

Operators have a low probability of achieving a successful cement job, if there is no total control of the well while drilling and circulating mud with the casing at total depth (TD) previous to the cement job. Thus, new technologies need to be considered to avoid extra NPT and overall rig costs.

Introduction

In this technical paper, a case history is presented to demonstrate an innovative solution to prevent and cure lost circulation while achieving excellent cement bond logs (CBL). This solution consists of pumping an innovative and unique cement spacer.

Lost circulation is defined as the partial or total loss of drilling fluids or cement slurries to the formation during the construction phase of the well. During the well drilling stage, losses tend to occur by one of these two mechanisms:

- Natural loses – occurs when fluid is lost to highly permeable, unconsolidated, fractured, cavernous or vugular formations
- Induced loses – occurs when excessive induced pressure hydraulically fractures the formation

The different types of lost circulation are shown in the following table:

Loss type	**Volume lost (bbl/hr)**
Seepage	<10
Partial	10-100
Severe	100-500
Total	>500 or no returns

Table 1 - (Estimated Volume lost per loss type)

Although there are several lost circulation treatments previous to cementing operations, loss circulation proves to be one of the main causes of non-productive time (NPT) during the drilling stage of the well.

Uncontrolled lost circulation while cementing leads to insufficient cement filling in the annular space, which jeopardizes the well integrity. Conventional methods are typically used to minimize lost circulation during the cementing stage. However, these conventional approaches solve the problem partially and eventually generate other problems.

The technology utilized to cure the losses in this case history is a novel spacer system, unique in the industry. This cement spacer mitigates lost circulation, minimizes filtration and damage to the formation, while preventing induced losses. Based on its ultra-low fluid invasion technology, the engineered spacer forms a strengthening barrier in the wellbore wall, which allows the formation to retain its integrity. This enables an optimized production with full returns due to the permeability property of the spacer.

If this cement spacer is pumped ahead of the cement slurry in operations with narrow ECD window, it can form an impermeable shield over the formation that allows the operator to exceed the fracture gradient without experiencing any cement losses.

Case History

A deep-water well located in southeastern Brazil, in the Santos basin, approximately 200 km (124 mi) from the coast and operating at 2,044 m (6,706-ft.) of water depth, was a challenge for both the operator and Baker Hughes. The operator encountered mud losses as they began to drill the production stage with a 12¼-in. bit. At this stage, approximately 36,000 barrels of synthetic-based mud (SBM) were lost.

Before running the 9 5/8-in. production liner, approximately 10-20 barrels per hour were lost to the formation. Considering this, the operator decided to use three cementing plugs to cover the entire open hole and remediate lost circulation before cementing.

After the lost circulation plugs, engineers waited on cement with the annular blowout preventer (ABP) closed and then, drilled out all of the cement. Engineers desired to find the well with no losses to run in the hole the 9 5/8-in. production liner to perform the cement job while achieving the total zonal isolation required. However, the operator was experiencing losses of 25-30 barrels of drilling mud per hour after drilling out the cement.

Baker Hughes recommended the use of SealBond/SealBond Plus to cure existing losses while preventing induced losses. This innovative spacer also allows better CBL results.

Baker Hughes designed and executed different compatibility tests for the spacer. When the best compatibility results were achieved, the results were presented to the operator's cement specialist along with the fluid friction chart (Figure 1). From the compatibility results, it was confirmed that rheological and friction hierarchies were easily achieved using SealBond. Following these results and various technical presentations, the operator believed that zonal isolation could be achieved without pumping a remedial job.

This was the first application of SealBond spacer in a deep-water cementing job in Brazil. The cementing job was carried out successfully as designed and all the parameters were met according to the technical cementing proposal. After 24 hours, a CBL was run. According to the operator, the results of CBL/VDL were incredible (Figure 2). Following this job the operators requested SealBond spacer for every rig in Brazil.

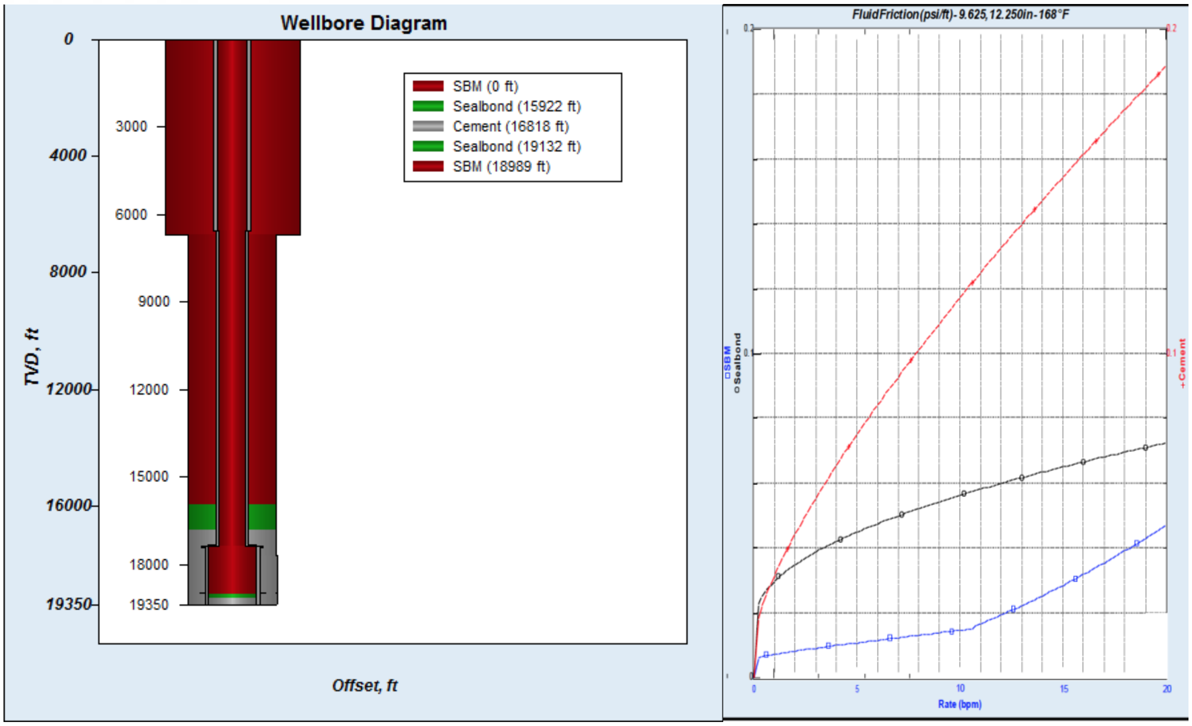
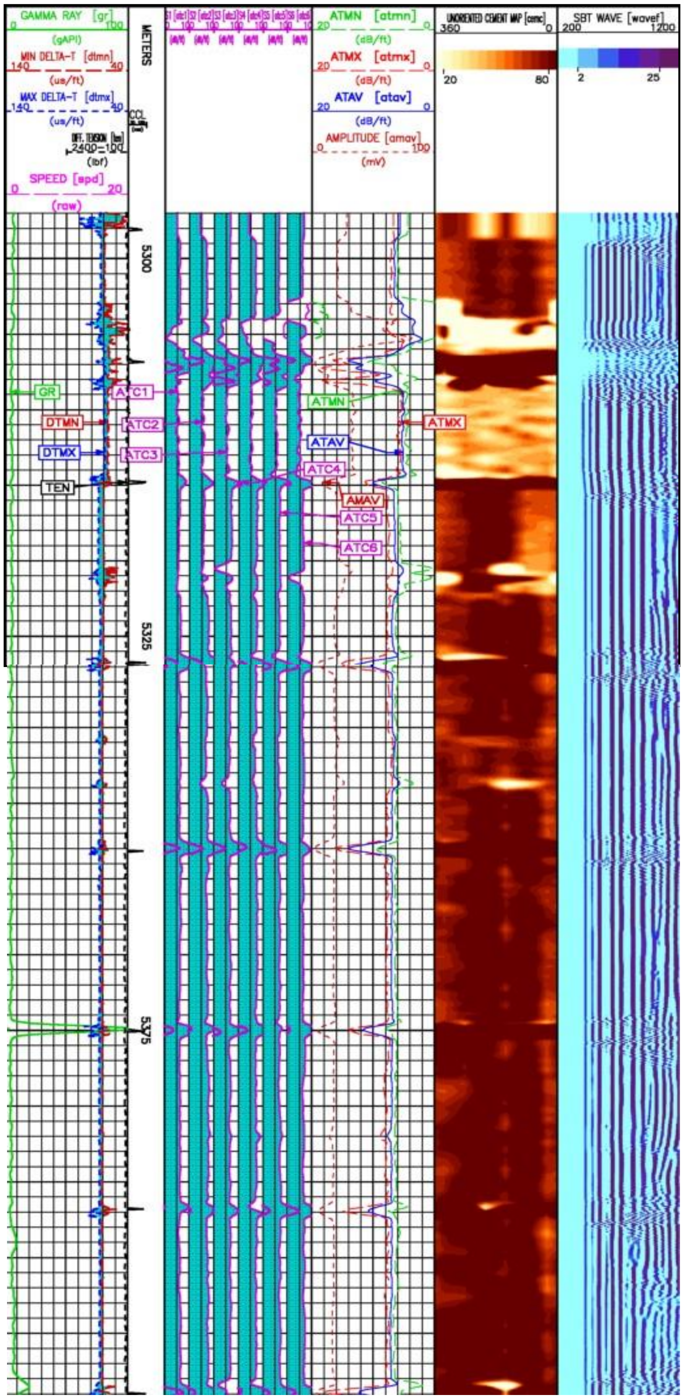


Figure 1 & 2 – Wellbore Diagram (left) Fluid Friction Chart (right)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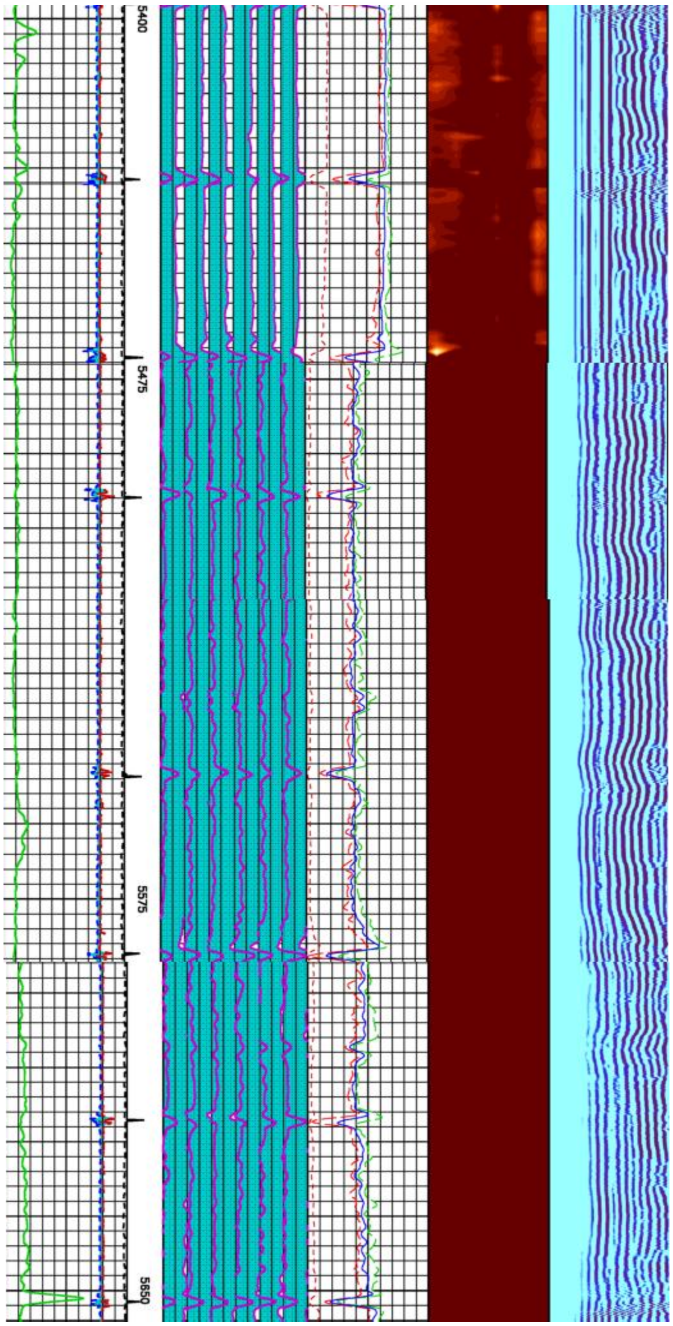
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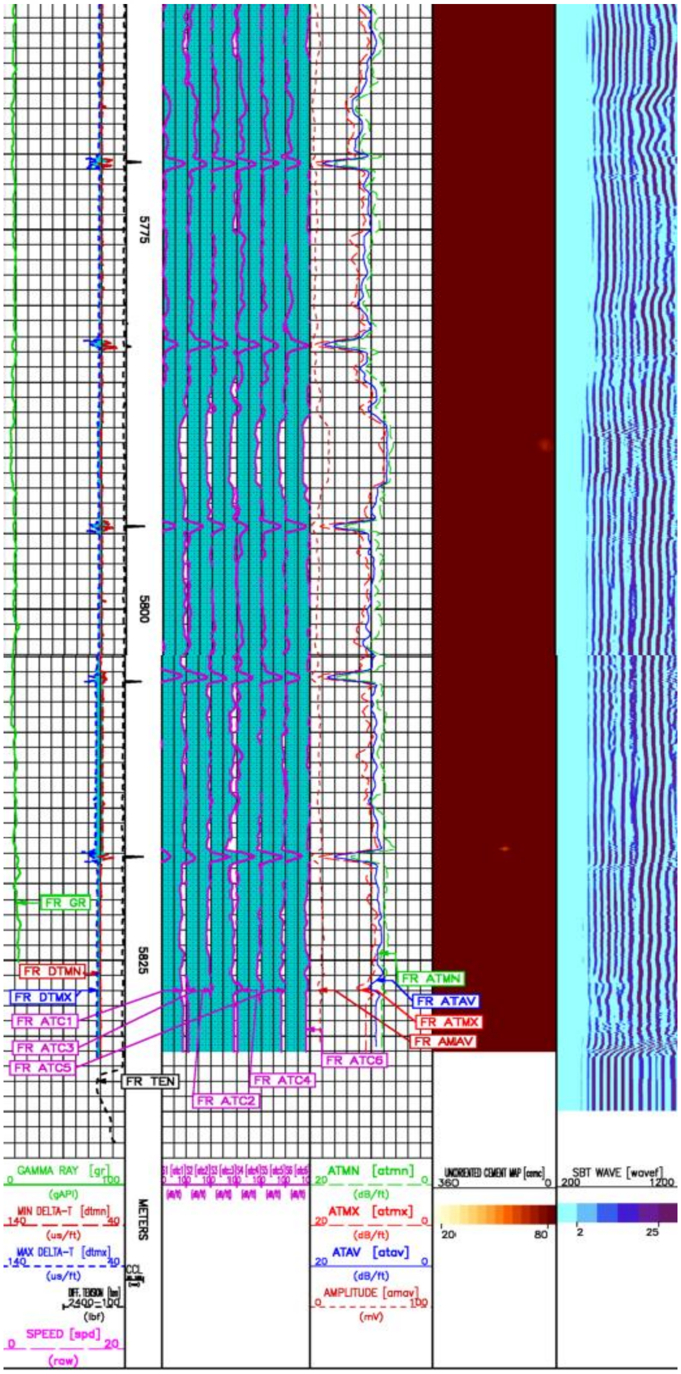

Figure 3 – CBL/VDL log chart

Conclusion

The case history presented in this technical paper demonstrates the ability of SealBond, to:

- Have a tremendous impact on the CBL achieving the desire top of cement by enhancing hole cleaning prior to cement placement and optimizing flow regime
- Cure pre-existing losses before the cementing job, increasing the probability of having a successful cementing job
- Avoid the necessity of remedial work
- Save costs to the operator, especially in deep-water operations and on the production stage

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Professional career of the author and co-authors:

Author
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Mechanical engineer graduated in 2003 from ITESM Campus Monterrey with 13 years of experience in cementing operations in the oil industry. Worked for Schlumberger from 2005-2010 as a field engineer in Ciudad del Carmen. Moved to Texas to work for Schlumberger from 2010-2013 as the engineer in charge for operations at Eagle Ford and Permian Basin. From 2013-2017, he worked with Sanjel and O-Tex Pumping as technical sales engineer. Currently, he is the global account manager at Impact for Baker Hughes.

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Electrical engineer graduated in 2006 from the Cesmac University in Brazil with 10 years of experience in cementing and stimulation. Worked for Baker Hughes from 2008 to 2010 in the Mossoro area as a field engineer. Currently, he is working for Baker Hughes in Macae as a DESC engineer for Petrobras.