Monitoring Contamination of Spacer Fluid by Resistivity

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Abstract:
In this study, contamination of a water based spacer fluid by drilling mud (water based and oil based) and cement slurry was monitored using electrical resistivity. With 5% of contamination, resistivity of water based spacer fluid increased by 10%, 8% and 1% for OBM, WBM, and cement slurry respectively.

1. Introduction

Achieving successful zonal isolation is an important step during oil/gas well drilling operations. The spacer fluid must isolate drilling fluid from cement slurry to avoid development of large interval of contaminated cement which would lead to severe consequences of gas migration [2, 4]. Also, the fluids and solids lost from slurries can cause damage by entering the formation and reducing their permeability which in turn decreases the productivity [3]. Hence, to avoid all these situations, a proper spacer mix should be employed before the cement is pumped. The main purpose of spacer fluid is to push the drilling mud out of the annulus and prepare the annulus area for cementing.

Previously, many studies have been conducted for making the oil well cement piezoresistive [1]. Resistivity measurements has proved to be a good monitoring method for studying the change in the properties of a material [1]. In this study, the same method of monitoring using resistivity was used to quantify the contamination in spacer fluid. Contamination can occur during the displacement process at the drilling mud-spacer fluid interface or at the cement slurry-spacer fluid interface [5]. Hence, it becomes important to know the contamination of spacer to achieve maximum displacement efficiency.

2. Objectives

The objective of this study was to quantify the contamination of a water based spacer fluid.

3. Material and Methodology

Oil Based Mud (density=0.8 g/cc) 4:1=oil:water, 1% (by total wt.) CTAB surfactant; spacer fluid (density=1 g/cc) 0.5% Guar gum, 0.4% Bio-Surfactant and 3% KCl; Cement slurry (density=2 g/cc) w/c=0.38, 0.075% carbon fiber. Resistivity was measured using API resistivity meter by contaminating spacer fluid with increasing percentages of oil based mud (OBM), water based mud (WBM) and cement slurry.

4. Results

Since the resistivity of oil based mud (OBM) is the highest, when the spacer fluid is contaminated by oil based mud, the resistivity value shows the highest increase and it lies between 0.25 Ω.m (resistivity of only spacer fluid) and 76 Ω.m (resistivity of only OBM). The next highest resistivity value is of water based mud. Hence, as the percentage of contamination increases, the resistivity also shows the change. The results for WBM lies between 0.25 Ω.m (resistivity of only spacer fluid) and 6.6 Ω.m (resistivity of only WBM). Cement slurry has a resistivity of 1.3 Ω.m. Therefore the contamination of spacer fluid by the cement shows the least resistivity values (Figure 1).

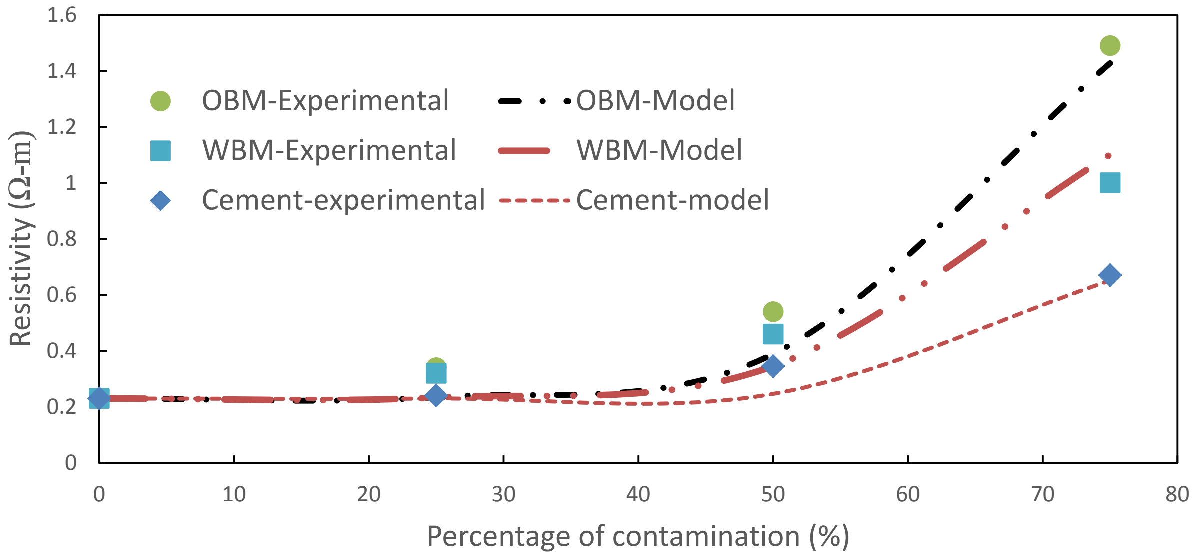

Figure 1: Change in resistivity of spacer with increasing Percentage of contamination

Fluid	$\rho_{o(\Omega.m)}$	m	n	R^2
OBM	0.23	5.5E-10	4.98	0.96
WBM	0.23	4E-10	4.98	0.91
Cement	0.23	5E-16	7.96	0.92

Table 1: Comparison of constants present in the model and R^2 for each curve

5. Model

For the resistivity (ρ) an equation was evaluated where ρ_o is resistivity of uncontaminated sample. Variable X is the percentage of contamination. 'm', 'n' and ρ_o were constants. The constant 'm' was least and 'n' was highest for cement contamination (Table 1). R^2 value for all the curves were more than 0.9. The equation that was evaluated was: $\rho = \rho_o + m\, X^n$

6. Conclusion

The contamination by OBM showed largest increase in the resistivity compared to WBM and cement slurry. Measuring electrical resistivity is a sensing ability by which contamination of the spacer fluid can be quantified.

7. Acknowledge

The study was supported by the THC-IT (http://egr.uh.edu/hurricane) with funding from DOE/NETL/RPSEA (Project 10121-4501-01).

8. References

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