Effect of Calcium Sulfate Contamination on the Resistivity and Rheological Properties of Bentonite Drilling Mud

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Abstract: In this study, the changes in electrical resistivity of drilling mud with different percentage of bentonite up to 8% with and without calcium sulfate contamination at room temperature was investigated. Drilling muds were contaminated up to 3% of calcium sulfate (by total weight of drilling mud). The results showed that the calcium sulfate decreased the resistivity of the drilling mud. Also the yield stress (Y_o) of the drilling muds decreased with increased amount of calcium sulfate concentration. The effect of calcium sulfate contamination on the resistivity of drilling mud at room temperature was quantified.

1. Introduction

Calcium sulfate has been cited in the literature as one of the major scales that cause many significant and serious operating problems in producing oil and gas wells and in water injectors. Impermeable hard scale deposits of calcium sulfate can severely impair the formation permeability, thereby decreasing the well injectivity or productivity. In addition, calcium sulfate can also negatively impact the well economics when it precipitates in downhole equipment, such as electrical submersible pumps (ESPs). This precipitation leads to pump failure due to over loading that causes serious damage to the pump components, and as a result, costly work overs are required (Delorey et al. 1996). Gypsum, the most common oil field calcium sulfate scale, is very difficult to remove. This is mainly because it has relatively low solubility limits in water; many publications have reported on the precipitation of calcium sulfate during different oil field operations, such as water injection, acid stimulation and commingled hydrocarbon/water production. The main cause of calcium sulfate scaling during these operations is the chemically incompatible mixing of two fluids (Mohammed et al. 2011).

2. Objectives

The objective of this study was to evaluate the effect of calcium sulfate contamination on the resistivity and rheological properties of drilling mud at room temperature.

3. Materials and Methods

In this study, four different percentages of bentonite (2%, 4%, 6% and 8%) were used. The resistivity of uncontaminated drilling mud was measured using the API resistivity meter and conductivity meter probe. Drilling muds were contaminated using different percentage of calcium sulfate up to 3% (by total weight of drilling mud). Two different resistivity devices were used to measure the resistivity of contaminated and uncontaminated drilling mud. API resistivity meter accurately measures the resistivity of fluids, slurries, and semi-solids with resistivity from 0.01 to 400 Ohm-meters. Conductivity meter was also used to compare the results with conductivity from 0–19.99 µS; 20–199.9 µS/cm. Both of the devices were calibrated using standard solution of sodium chloride (NaCl).

4. Analysis and Discussion

The resistivity of uncontaminated drilling mud decreased by 39%, 27% and 53% when the bentonite content were 2%, 6% and 8% respectively as shown in Fig.1. Additional of 3% of calcium sulfate (by total weight of drilling mud) the resistivity decreased for all the bentonite percentages. Additional of 3% of calcium sulfate to the 2%, 4%, 6% and 8% bentonite drilling mud decreased the yield stress (determined using the Bingham model) by 75%, 49%, 66% and 51% respectively as shown in Fig.2. Based on the inspection of the test data for the properties investigated following relationships is proposed.

$$\rho - \rho_o = \left(\frac{CS}{D+E*CS}\right) \ldots\ldots\ldots\ldots\ldots\ldots (1)$$

Where: ρ= resistivity of drilling mud contaminated with calcium sulfate, ρ_o = resistivity of uncontaminated drilling mud, CS= calcium sulfate concentration (%), D and E = model parameters. Model parameters, coefficient of determination (R^2) and root mean squared error (RMSE) are summarized in Table 1.

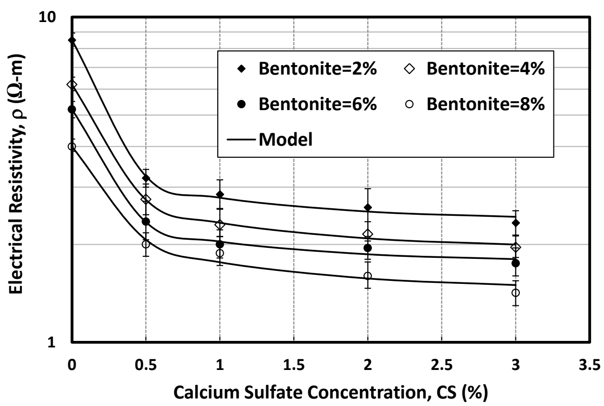

Figure 1. Relationship between Resistivity and Calcium Sulfate Concentration for various Drilling Muds

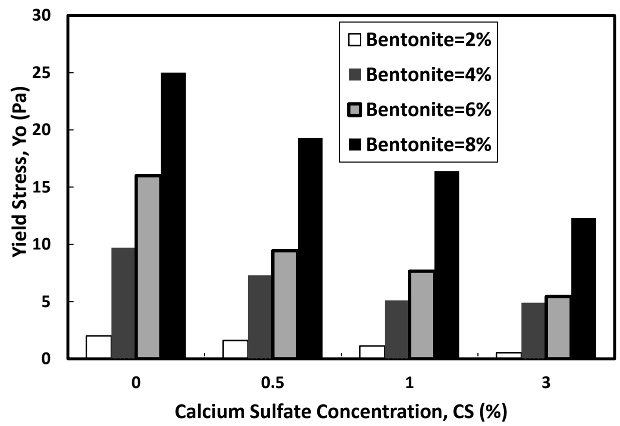

Figure 2. Calcium Sulfate Concentration Effect on the Yield stress of Drilling Mud

Table 1. Model Parameters for Calcium Sulfate Contaminated Drilling Mud

Bentonite, B (%)	ρ_o	D	E	R^2	RMSE (Ω-m)
2	8.50	-0.02	-0.16	0.99	0.022
4	6.20	-0.03	-0.23	0.96	0.006
6	5.20	-0.03	-0.28	0.99	0.012
8	4.00	-0.07	-0.38	0.95	0.026

5. Conclusions

Based on this study on 3% calcium sulfate contaminated drilling mud, the resistivity of the drilling muds decreased by 73%, 68%, 66% and 65% for drilling muds with 2%, 4%, 6% and 8% of bentonite respectively. Additional of 3% of calcium sulfate to the 2% and 8% bentonite drilling mud decreased the yield stress by 75% and 51% respectively at T=25^{o}C.

6. Acknowledgements

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7. References

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