Effect of Gypsum on Resistivity of Water Based Drilling Mud

H. I. Kula and C. Vipulanandan, Ph.D., P.E.
Center for Innovative Grouting Material and Technology (CIGMAT)
Department of Civil and Environmental Engineering
University of Houston, Houston, Texas 77204-4003
E-mail: halilibrahim_kula@hotmail.com, cvipulanandan@uh.edu Phone: (713) 743-4278

Abstract: In this study, the changes in electrical resistivity of drilling mud with different percentage of bentonite up to 6% 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. 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. Objective: The overall objective was to quantify the changes in the properties of a water drilling mud by varying the calcium sulfate content.

3. Materials and Methods: In this study, four different percentages of bentonite (1%, 2%, 4% and 6%) were used. The resistivity of uncontaminated drilling mud was measured using the API resistivity meter. Drilling muds were contaminated using different percentage of calcium sulfate up to 3% (by total weight of drilling mud).

Figure 1. API resistivity meter

4. Results and Analysis: The resistivity of uncontaminated drilling mud decreased by 55%, 63%, 66% and 71%. when the bentonite content were 1%, 2%, 4% and 6% respectively as shown in Fig.2. Additional of

0.1, 0.5, 1.0 2.0 3.0 % of calcium sulfate (by total weight of drilling mud) the resistivity decreased for all the bentonite percentages. Furthermore, the change in decreasing resistivity was calculated with different concentration of $CaSO_4$ without bentonite. Based on the inspection of the test data for the properties investigated following relationships is proposed.

$$\rho - \rho o = \frac{CS}{A + B * CS} \quad (1)$$

Where: ρ = resistivity of drilling mud contaminated with calcium sulfate, ρo = resistivity of uncontaminated drilling mud, CS= calcium sulfate concentration (%), A and B = model parameters. Model parameters, coefficient of determination (R_2) in Table 1.

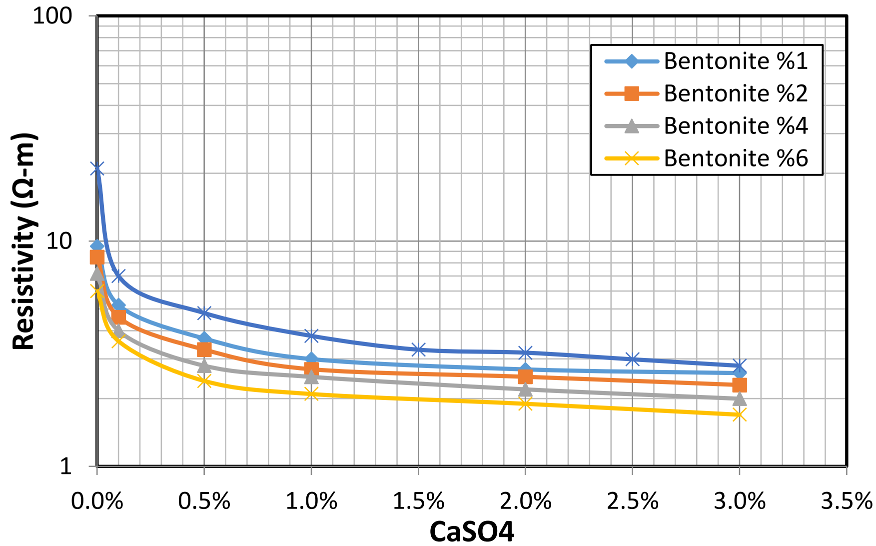

Figure 2. Relationship between Resistivity and Calcium Sulfate Concentration for various Drilling Muds

Table 1.Model Parameters for Calcium Sulfate Contaminated Drilling Mud

Bentonite	R_0	A	B	R^2
0%	20.99	-0.002	-0.05	0.99
1%	9.5	-0.016	-0.139	0.98
2%	8.5	-0.017	-0.156	0.99
4%	7.2	-0.02	-0.19	0.99
6%	6	-0.2	-0.23	0.98

5. Conclusion: Based on this study on 3% calcium sulfate contaminated drilling mud, the resistivity of the drilling muds decreased by 71%, 66%, 63% and 55% for drilling muds with 1%, 2%, 4% and 6% of bentonite respectively and Temperature was 25^oC.

6. Acknowledgements: This study was supported by the Center for Innovative Grouting Materials and Technology (CIGMAT), University of Houston, Houston, Texas with funding from the Ultra Deepwater Program DOE/NETL/RPSEA (Project No. 10121-4501-01).

7. References:

[1] Delorey, J., Allen, S. and McMaster, L. (1996) "Precipitation of Calcium Sulfate during Carbonate Acidizing: Minimizing the Risk" Petroleum Society of Canada paper 96-84, presented at the 47th Annual Technical Meeting, Calgary, Alberta, Canada.

[2] Al-Khaldi, M., Al-Juhani, A., Al-Mutairi, S. and Nihat, G. (2011) "New Insights into the Removal of Calcium Sulfate Scale." Saudi Aramco Journal of Technology, Vol. 20, pp.43-51.