Effect of Salt Contamination on the Bentonite Drilling Mud Shear Strength and Electrical Resistivity

Aram M. Raheem and C. Vipulanandan
Texas Hurricane Center for Innovative Technology (THC-IT)
Department of Civil and Environmental Engineering
University of Houston, Houston, Texas 77204-4003
Email: amraheem@uh.edu, cvipulanandan@uh.edu
Phone:(713)743-4278

Abstract: In this study, both shear strength and the changes in the electrical resistivity of different Bentonite drilling mud contaminated with salt have been quantified experimentally and modeled mathematically. Both shear strength and the changes in the electrical resistivity have decreased as the salt contamination increased. Similar model predication can be adopted for both shear strength and the changes in electrical resistivity with high degree of correlation (R2) and minimum root mean square error (RMSE).

1. Introduction

High demands on oil and gas of the world require to look for oil in deeper and more challenging reservoirs. One of the most challenging associated with drilling deep and ultra-deep wells is to maintain desirable rheological properties of the drilling fluids (Hassiba and Amani 2013) where salt can be one of the sources of contaminations that affects the drilling mud properties. Bentonite mud can be contaminated during drilling of salt beds and the probability to encounter such type of layer during drilling operation is higher for deep wells. In addition, salts also can be present by design such as salts added to the drilling fluid system to have a salt saturated water based mud, or in offshore operations where seawater is used in preparing the drilling fluids (Rossi et al. 1999). Bentonite clays in fresh water are effective for controlling the amount of fluid loss to the formation, by the formation of a "mudcake" along the walls of the wellbore. But under saline conditions in the wellbore, the filtration control is lost due to flocculation of the clay particles. Furthermore, shale swelling within the formation may have negative consequences during the drilling operation (Sherwood 1994). Hence, the salt effect on the shear strength and electrical resistivity of the drilling mud is desirable.

2. Objectives

The objective of this study was to quantify the shear strength and the changes in the electrical resistivity of different Bentonite drilling mud contaminated with salt. Furthermore, mathematical model quantification was proposed to predict both shear strength and the changes of electrical resistivity.

3. Methods and Materials

In this study, different bentonite drilling mud (2%, 4%, 6%, 8% and 10%) was studied under various salt contaminations (0.1%, 1% and 3%). Shear strength was measured using modified vane shear device while the changes in the electrical resistivity were quantified using AC-LCR meter.

4. Model

The following mathematical models were used to predict the shear strength and the changes in the electrical resistivity of drilling mud due to salt contamination:

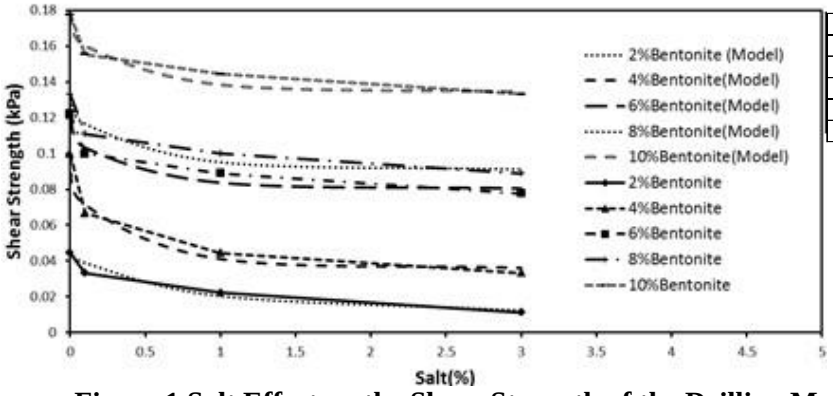
$$Shear\ Strength\ (kPa) - Su_o(kPa) = \frac{Bentonite(\%)*Salt(\%)}{A+B*Salt(\%)} \quad (1)$$

$$\left(\frac{\Delta\rho}{\rho_o}\right)*100\% - \left(\frac{\Delta\rho}{\rho_o}\right)_o*100\% = \frac{Bentonite(\%)*Salt(\%)}{A+B*Salt(\%)} \quad (2)$$

Where: A and B are model parameters, Su_o= initial shear strength, $(\Delta\rho/\rho_o)$ and $(\Delta\rho/\rho_o)_o$ are the changes in the electrical resistivity to the initial resistivity and the initial changes of the electrical resistivity, respectively.

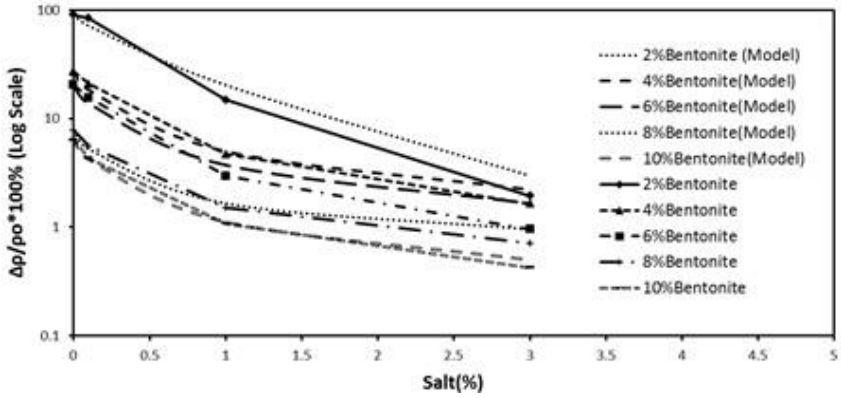
5. Results

The effect of salt on shear strength with model parameters is shown in Fig.1. While Fig.2 has shown the effect of the salt on the change of the electrical resistivity with the model parameters.



Bent.(%)	A	B	R^2	RMSE
2	-31	-52	0.941275	0.0030089
4	-8	-60	0.984078	0.0032108
6	-18	-138	0.958079	0.003363
8	-30	-180	0.94538	0.0038387
10	-35	-220	0.946104	0.0038132

Figure 1 Salt Effect on the Shear Strength of the Drilling Mud with Different Bentonite Content



Bent.(%)	A	B	R^2	RMSE
2	-0.0085	-0.02	0.969542	6.949438032
4	-0.03	-0.15	0.984184	1.350771686
6	-0.06	-0.3	0.98383	1.045328273
8	-0.2	-1.1	0.994464	0.216767482
10	-0.3	-1.6	0.999029	0.075591609

Figure 2 Salt Effect on the Resistivity Change of the Drilling Mud with Different Bentonite Content

6. Conclusions

Both shear strength and the change in the resistivity of the drilling mud has decreased as the salt content increased and the proposed mathematical models have a very good agreement with the experimental results.

7. Acknowledgement

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8. References

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