Effect of Oil Contamination and Temperature on the Resistivity of 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 oil spill contamination was investigated. Also the effect of temperature up to 85 ^{o}C on contaminated and uncontaminated drilling mud was studied. Drilling muds were contaminated up to 12% of oil (by total weight of drilling mud). The resistivity of contaminated and uncontaminated samples using were measured using the resistivity meter and conductivity meter probe. The results showed that the oil increased the resistivity of the drilling mud. Also the resistivity of uncontaminated and contaminated drilling muds decreased with increasing the temperature. The effect of oil-contamination on the resistivity of drilling mud was quantified.

1. Introduction
Drilling muds are fluids used to control formation pressures, lubricate and cool the bit, remove rock fragments from the drilling well, and form a consolidated wall cake on the sides of the hole prior to casing. These muds, which are highly viscous, are complex formulations and include such finely divided materials as ground ilmenite, bentonite, various clays, barite, lead ore, fibers, hulls, etc. in a liquid medium which may be aqueous (e.g., water or brine) or an oil Goodarznia et al. (2006). There are several potential sources of oil leakage to the surrounding ecosystem through damaged pipeline, discharges from coastal facilities, offshore petroleum production and natural seepage. Improper management of used engine oil and illegal dumping of other hydrocarbon components could also contaminate the drilling mud. Oil spillage or leakage will contaminate the soil and water system. Oil contamination of the drilling mud could alter the rheological properties of oil-contaminated drilling mud (Gozalpour et al. 1998).

2. Objectives
The objective of this study was to evaluate the effect of oil contamination on the resistivity of drilling mud under different temperatures.

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 under varying of temperature up to 85 ^{o}C. Drilling muds were contaminated using different percentage of oil up to 12% (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 resistivities 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 was decreased by 34%, 54% and 69% when the bentonite content changed from 2% to 4%, 6% and 8% respectively. Additional of 3% of oil (by total weight of drilling mud) the resistivity increased for all the bentonite percentages. The resistivity of

uncontaminated 2% bentonite drilling mud decreased by 50% when the temperature changed from 25 ^{o}C to 85 ^{o}C. Based on the inspection of the test data for the properties investigated following relationships is proposed.

$$\rho - \rho_o = \left(\frac{X}{P+Q*X}\right) \text{..... (1)}$$

Where: ρ= resistivity of drilling mud contaminated with oil, ρ_o = resistivity of uncontaminated drilling mud, X= oil content (%), P and Q = model parameters. The model parameters were related to the test variables as follows:

$$P \text{ or } Q = N * X^{L} * B^{M} \qquad for \text{ B and } X > 0\% \text{.....(2)}$$

Where:
B= Bentonite content and N, L and M are model parameters.

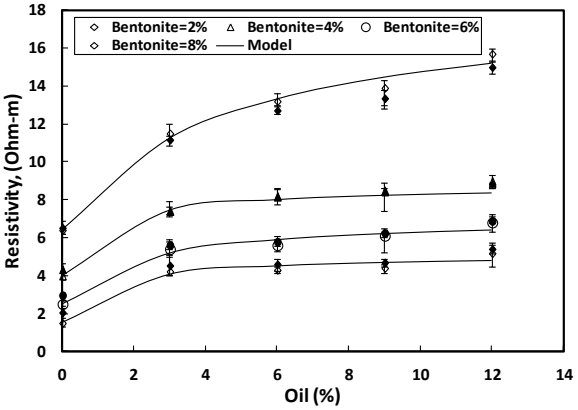

Figure 1. Relationship between Resistivity and Oil Content for various Drilling Muds

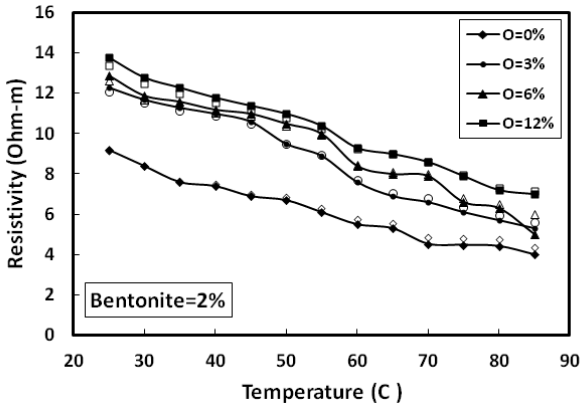

Figure 2. Temperature Effect on 2% Drilling Mud with Varying Amount of Contaminated Oil

Table 1. Model Parameters for Oil Contaminated Drilling Mud (X %> 0)

	P	R^2	Q	R^2
N	0.015		0.05	
L	-0.88	0.91	-0.01	0.89
M	3.1		0.9	

5. Conclusions

Based on this study on oil contaminated drilling mud, the resistivity of the drilling muds was increased by 56%, 51%, 57% and 63% for drilling muds with 2%, 4%, 6% and 8% of bentonite and contaminated with 12% of oil respectively. For the uncontaminated 2% of drilling mud the resistivity decreased by 50% when the temperature was changed from 25 ^{o}C to 85 ^{o}C.

6. Acknowledgements

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7. References

1. Gozalpour, F. and Heriot-Watt, U. (1998)." Determination of Reservoir Fluid Properties from Samples Contaminated with Oil-Based Mud Filtrate" SPE 52062-STU, pp.1-3.
2. Goodarznia, I. and Esmaeilzadeh, F. (2006)." Treatment of Oil-Contaminated Drill Cuttings of South Pars Gas Field in Iran Using Supercritical Carbon Dioxide" Iranian Journal of Science & Technology, Transaction B, Engineering, Vol. 30, No. B5, pp. 607-611.