Effect of Salt Water Contamination on the Curing and Piezoresistive Behavior of Smart Cement

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Abstract
In this study the salt water contamination on the smart cement's piezoresistive behavior was investigated. Sea water salt concentration (3-5%) was used to prepare the salt water. Initial resistivity of the control specimen was 1.07 and salt contaminated specimens was 0.39, 0.2 and 0.15. Piezoresistivity at failure of the control specimen was 54% and the salt contaminated specimens was 81%, 87% and 108% respectively. Compressive strength increased with the increase in salt content.

1. Introduction

During the event of a hurricane, there is a high probability of the oil wells getting affected by the sea water brought along. The salt in the sea water would contaminate the cement during its initial installation in the oil well. Salt water can have several impacts on the factors which govern the setting time, compressive strength and piezoresistive behavior of the cement. Experimental studies have shown the effect of salt water contamination on the compressive behavior of cement. Hence there is a need to quantify the properties of the oil well cement slurry in its fresh and hardened state, which is prone to salt water contamination.

2. Objective

The objective of this study was to investigate the effect of salt water contamination on the oil well cement's curing and piezoresistive behavior.

3. Materials and Methods

Class H Oil Well Cement of 330 g was used for each sample. The blender was used to prepare the smart cement samples. Initially water was poured into the blender, maintaining a W/C ratio of 0.38 for all the samples. Conductive filler of 0.06% by the weight of cement was used and dispersed into the water slowly to obtain a uniform dispersion. NaCl of 1%, 3% and 5% by the weight of cement was added into the blender in 3 different batches each along with the cement and blended for about 2 to 3 min. The initial resistance profile was monitored using the two probe method, with the E4980A precision LCR-Meter. Resistivity was monitored for the initial 4 hours and after 24 hours for all the specimens using the digital resistivity meter. Compression test was performed after one day to investigate the piezoresistive behavior of different salt contaminated smart cement specimens.

4. Results and Discussion

The resistivity of the samples was monitored and it was observed that the initial resistivity of the samples decreased with an increase in the salt content. This increase can be attributed to the concentration and mobility of the ions in the slurry state. Fig 1 shows that, initial resistivity of the control sample was 1.07Ω-m and the samples contaminated with 1%, 3% and 5% NaCl were with 0.39, 0.20 and 0.15Ω-m respectively.

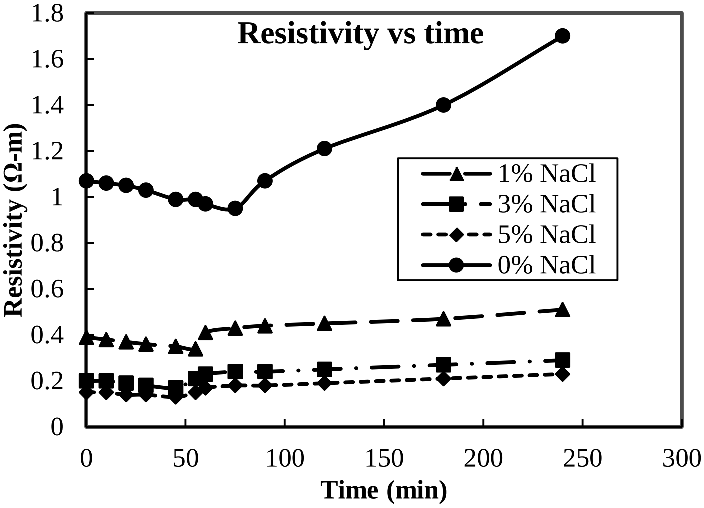

Fig 1: Resistivity vs time (depicts the curing behavior of smart cement)

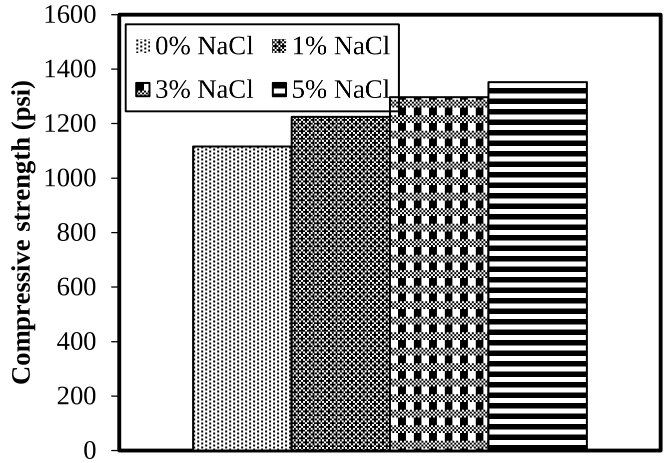

Fig 2: Compressive strength of the smart cement samples with varying % of NaCl

Initial setting time (t min) observed was around 75 min for the control sample. For the samples with 1%, 3% and 5% salt contamination, the initial setting time was 55min, 45 and 40 min respectively. In Fig 2 it can be seen that the compressive strength, increased with an increase in the percentage of salt contamination. From Fig 3 we can learn that piezoresistivity at failure for the control specimen was 54% and for the salt contaminated specimens it was 81, 87 and 108% for 1, 3 and 5% NaCl respectively.

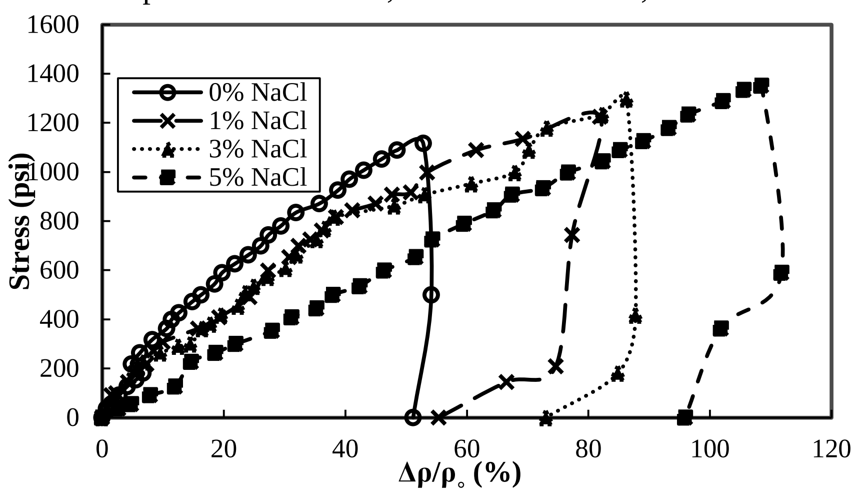

Fig 3: Piezoresistivity of the smart cement varying with % of NaCl

4. Conclusions

1. Initial resistivity and the initial setting time of the smart cement, decreased with the addition of salt solution into the cement slurry.
2. Piezoresistivity at failure increased with the increase in the percentage of salt contamination.
3. Compressive strength also increased with the increase in the percentage of salt contamination.

5. Acknowledgment

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6. References

Preeti Tiwari et al., (2014). "Effect of salt water on compressive strength of concrete". International Journal of Engineering Research and Applications, Vol 4, pp 38-42.