Effect of Temperature on the Resistivity of Modified Oilwell Cement mixed with salt water

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Abstract: In this study changes in the electrical resistivity of oilwell cement mixed with salt water was studied at a curing temperature of 170°F. Salt water reduced the resistivity. With 6% salt, the resistivity was reduced by over 80%.

1. Introduction

Traditional cement designs for salt formations have used salt-saturated slurries, assuming they would bond better with salt formations, resist chemical attack, reduce the tendency for gas migration during setting and would be less likely to dissolve salt formations. However, at concentrations from about 18% by weight of water to saturation, salt retards thickening time, reduces compressive strength, increases thickening time, and promotes fluid loss and free-water content (Ludwig, 1951). Thickening time using sea water is reduced by about 35.7 percent from that obtained from fresh water, also using sea water generally increase the early strength development, thereby decreasing the waiting on cement time(Smith, 1975). On the other hand at higher temperatures, hydration starts faster and it leads to accelerated hardening of cement.

2. Objectives

The objective of this study was to investigate the effect of using salt water to prepare the cement slurry. Resistivity was used as the monitoring parameter during early curing.

3. Materials and Testing Method

All the materials were mixed at room temperature and cured at 170°F. Cement Class H with Different percentages of salt (NaCl) (0, 2%, 6%) were added to the modified cement with 0.2% conductive additive. Water-to-cement ratio was 0.5 and Silica fume was added. The two probe calibration factor, k(R=ρk), was about 50,000 for the specimens without salt contamination and 120,000 for specimens with salt contamination. These results were for two wires placed at a vertical distance of 1 inch. To represent the field condition, the specimens were cured in saturated sand, a new method developed recently.

4. Results

Figure 1 shows initial resistivity at room temperature with different salt percentages. Slurries with higher percentage of salt had low resistivity, because of the increase in ionic content in the slurry. In this new way of curing, the weight loss was nearly zero. As shown in Fig 2, the resistivity changed initially and stabilized after 4 hours. The minimum resistance was observed with both specimens after 50 minutes. After minimum resistance, resistance increased and it was because of hydration and after about

4-5 hours resistivity decreased. As mentioned before, specimens were cured in saturated sand. It was observed specimens weight increased with time especially for specimens with high percentage of NaCl. It could be a reason for the decrease in electrical resistivity after 4-5 hours of mixing.

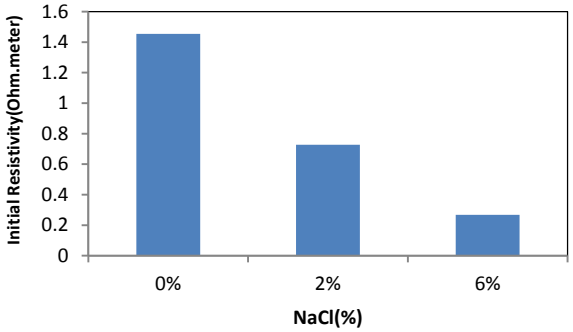

Figure 1: initial resistivity for slurries with different salt percentage(mixed at room temperature)

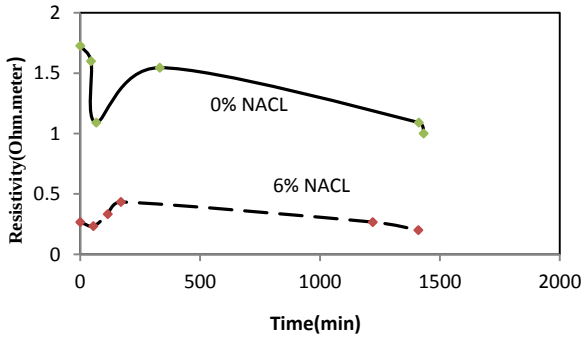

Figure 2: Resistivity change during curing for slurries with 0 and 6 percent of salt at 170°F.

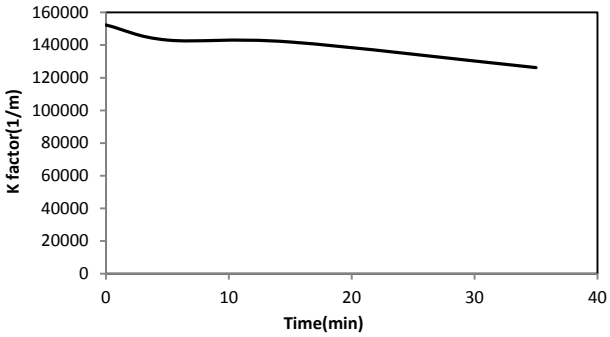

Figure 3: K factor for specimen with 6% NaCl.

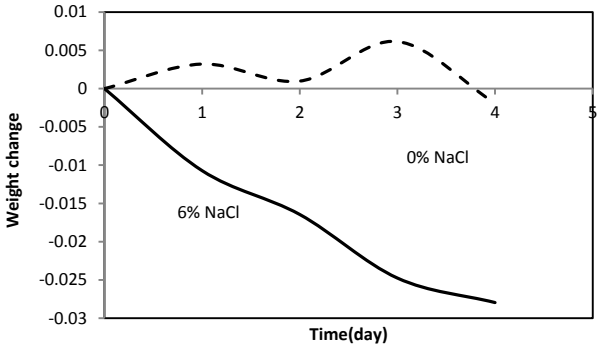

Figure 4: weight change during curing.

5. Conclusion

The conclusions are based on the tests performed at 170°F with varying amount of salt content. The conclusions are as follows:

1. Initial resistivity for slurry with 6 percent salt water was about 80% lower than the cement with water.
2. During the initial curing at 170°F resistivity reduced to a minimum within first 50 minutes of curing.

6. Acknowledgements

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7. References

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