Change in Electrical Resistivity of Modified Oil Well Cement with Nanosilica

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Abstract: Electrical resistivity at room temperature was monitored during the early age curing of class H oil well cement modified with nanosilica. For this study, 0.3% of nanosilica, based on weight of cement was used. Comparison was made between samples with 0.3% nanosilica and samples without nanosilica. Electrical resistance values were also monitored to investigate the change in K with time. It was found that addition of 0.3% nanosilica increases minimum electrical resistivity, ρ_{min} by about 35%. Duration to reach this resistivity, t_{min} also decreases. In addition, change in density for adding nanosilica was also studied and it was found to decrease with addition of nanosilica.

1. Introduction

The quality of the cement behind a casing plays a very important role during drilling and production period of the well. It also has a serious impact on secondary cementing. Hence, continuous monitoring of cement based material in oil well is necessary to avoid failure and other adverse consequences. In addition, electrical resistivity is a good parameter to monitor the behavior of cement. Meanwhile, one of the most useful nano materials that has received considerable attention in many fields, especially in oil well cement is nanosilica [1]. The acceleration of the hydration reaction in oil well cementing is also important because it deceases the wait-on-cement (WOC) time. A shorter WOC is desirable for saving rig time, which can be very expensive in offshore wells [2]. Nanosilica is known to provide this behavior in cement as it is a good accelerator for cement hydration. Furthermore, increase in density due to nanosilica addition into cement slurry is based on transformation of water into crystal bound water, which is responsible for a small expansion of cement slurries [3].

2. Objective

The main objective of this study was to investigate the effect of addition of 0.3% of nanosilica on the electrical resistivity of modified class H oil well cement. Change in the calibration parameter K with time was also investigated.

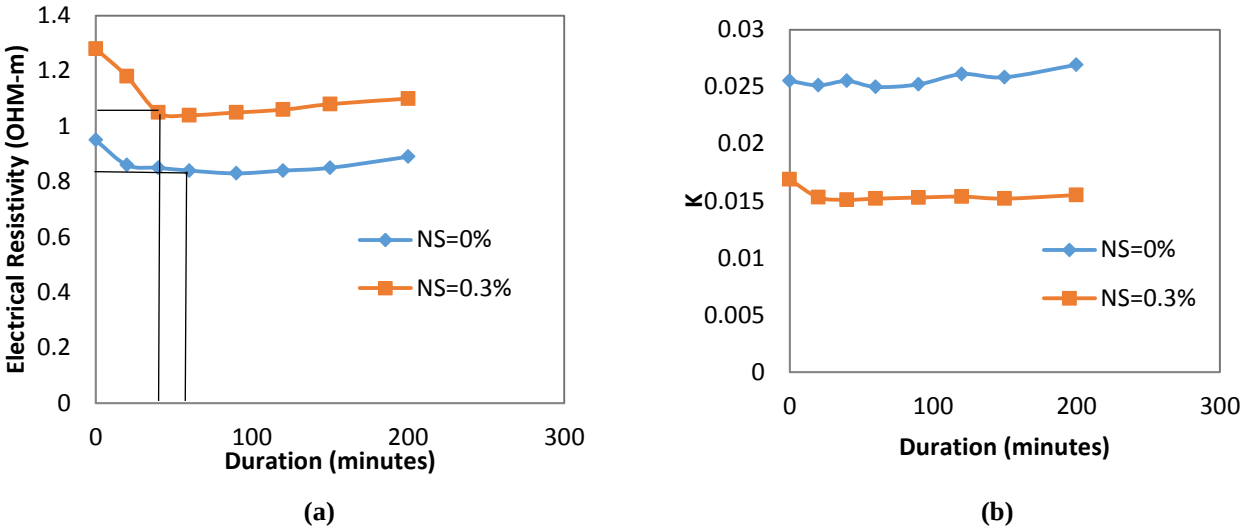
3. Materials and methods

Class H oil well cement and water to cement ratio of 0.4 was used in the experiments. Carbon fiber at a percentage of 0.075% was incorporated. The cement was further modified by adding nanosilica at 0.3%. Specimens were cured in room temperature. Commercially available precision LCR instrument (AC) was used to measure electrical resistance. Resistivity meter was used to measure the electrical resistivity. The cement mix was placed in a plastic cylinder mold of 2 inches in diameter and 4 inches in height. Each mold had 2 wires installed to measure the electrical resistance.

4. Results and Analysis

The density of modified cement with and without nanosilica was found to be 2.078 gm/cm^3 and 2.095 gm/cm^3 respectively. Hence the density lowers, which is also in accordance with the literature. Electrical resistivity was investigated during the early curing age of the studied slurry; in this case it was for first two hundred minutes after preparation of the slurries. It is found that, adding nanosilica of 0.3% increases resistivity value by about 25% to 35%. For ρ_{min} this change is about 25%, while the change for initial

resistivity was found to be 35%. Meanwhile, the value of calibration parameter K decreases about 35% and when nanosilica is present, it comes to constant value of around 0.0153 after thirty minutes of preparing cement slurry. Resistivity decreases gradually from initial value and comes to a minimum value for both cases after which it starts to increase. However, adding 0.3% nanosilica reduces the time, t_{min} to reach this minimum value, $\rho_{min.}$ The difference of t_{min} for this study was found to be about 35%. This phenomenon is probably due to the accelerated hydration of cement past and faster formation of calcium hydroxide at initial period in presence of nanosilica [4].



(a) **(b)**

Figure 1. (a): Electrical Resistivity Vs. Duration; (b): K Vs. Duration

5. Conclusion

With addition of 0.3% nanosilica electrical resistivity values increase up to 35%. Time needed to reach minimum resistivity value also decreases about 35% in this study during early age curing time of about 200 minutes.

6. Acknowledgement

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

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