Piezoresistive Behavior of Modified Oil Well Cement with Nickel Nanoparticles

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Abstract: Piezoresistive behavior of modified and regular class H oil well cement (owc) with the addition of low concentrations of nickel nanoparticles was studied. The result showed that nickel nanoparticles of 0.075% enhanced the piezoresistive behavior of OWC and modified OWC after three days curing at room temperature. With the addition of Ni nanoparticles the normalized resistivity at failure for OWC and modified OWC were 50% and 150% respectively.

1. Introduction

Nanoparticles have been incorporated into cement or concrete for improved physical and mechanical properties. Most studies incorporated SiO_2, few studies also focused on using nano-Fe_2O_3, and nano-CuO (Khoshakhlagh *et al*. 2012; Nazari and Riahi 2011). Nanoparticles was used to reinforce the concrete or cement, and also it is a good disperser. Nickel powders in micron scale (20~24 vol% to cement) was incorporated into cement-based composite to obtain piezoresistive property of the material, as nickel is an effective component or filler to fabricate piezoresistive composites with macromolecule materials as matrix (Han *et al*. 2010; Han *et al*. 2009). While no nano-scale nickel particles in low concentrations was incorporated into cement composite. This study produced nickel nanoparticles, and incorporated low concentrations of the particles into a oil well cement to study the mechanical property change of the cement. Leaching test of the nickel nanoparticles will be carried out in the future to study nickel nanoparticles' effect on the well environment.

2. Objectives

The overall objective was to investigate the effect of nickel nanoparticles on the piezoresistive properties of regular and modified (conductive filler) class H oil well cement.

3. Materials and Methods

Nickel nanoparticles (Ni NP) was made by the precipitation method. Briefly, 1.3 g $NiCl_2 \cdot 6H_2O$ was mixed with 0.25 g CTAB in D.I. water, 0.3 g of $NaBH_4$ was added to precipitate nickel nanoparticles. After 15 min, the nanoparticles was washed with acetone for several times before drying for use. The reaction is:

$$NiCl_2 + 2NaBH_4 + 6H_2O \rightarrow Ni\downarrow + 7H_2\uparrow + 2B(OH)_3 + 2NaCl \quad \text{.....} \quad (1)$$

Class H oil well cement (API class H-high sulfate resistant) was used. The modified OWC included a low concentration of conductive filler. Nickel nanoparticles of 0.075% (based on cement weight) were incorporated. Cement samples were prepared with water to cement ratio of 0.4. Nickel nanoparticles were suspended in water, then the cement was added into the water. Oil well cement without addition of the particle was prepared as control. The samples were cured in a 3.5 inch long, 1.5 inch diameter cylinder for 3 days at room temperature. Change of resistance with change of compressive stress was measured. Duplicate specimens were tested under each condition. Change of nominal resistivity was obtained based on the change of resistance.

4. Results and Discussion

Addition of 0.075% of nickel nanoparticles enhanced the compressive strength of the oil well cement by 30% to 1930 psi. Addition of the nickel nanoparticles to the modified OWC enhanced the compressive strength by 35%, and addition of nickel nano particles affected the resistivity of the cement. As shown in Fig. 1, addition of nickel nanoparticles to the modified cement substantially improved the piezo resistive behavior of the cement.

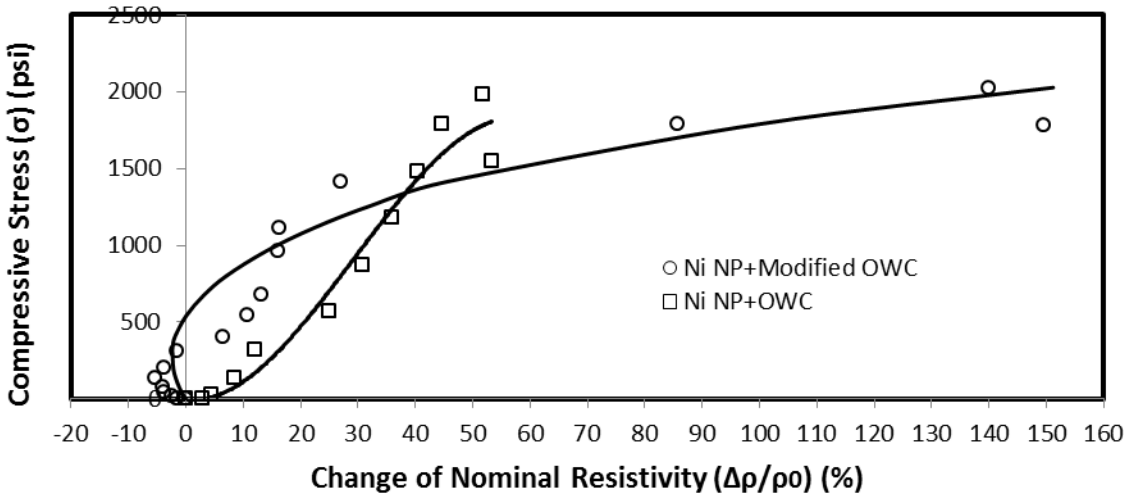

Figure 1. Piezoresistive Behavior of Ni Nanoparticle Added OWC Cement

5.Conclusions

Addition of nano nickel nanoparticles enhanced the piezoresistive behavior of the oil well cement with and without modification.

6. Acknowledgements

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7. References

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