Effect of Oil Contamination on the Electrical Properties and Compressive Strength of Modified Oil Well Cement

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Abstract
The effect of oil contamination on the modified oil well cement with and without metakaolin was investigated. During this study, the portion of oil added into the cement mixture was 4 percent. The oil contamination increased the resistivity of the slurry during the hydration of the cement and also affected both the piezoresistive behavior and the compressive strength of the oil well cement.

1. Introduction
Over the past two decades, the amount of hydrocarbon contamination of cement has increased and has resulted in damaging of the oil wells. Some sources of hydrocarbon contamination are oil spill, leaking of petroleum from underground storage tanks, oil pipe vandalisation, drilling, and treatment activities for exploration and production of hydrocarbons and hydrocarbon waste disposed from industries. Also hurricanes can affect the oil spillage on the off Shore platforms [1]. Previous studies have been focused on the effect of oil spill on the compressive strength of Portland cement but there is very limited information on the electrical properties of oil well cement contaminated with oil. In this study the effect of oil contamination on electrical properties and compressive strength of modified oil well cement class H was investigated.

2. Objective
Main objective in this study was to investigate the oil contamination on the electrical properties of the modified oil well cement, and also its effect on the compressive strength.

3. Materials and Methods
The cement was mixed with 10% metakaolin and then water was added. The water-to-cement ratio (including Metakaolin) was 0.45 for both metakaolin and control specimen. 4% DTE oil as contamination was added to both types of specimens, and then they were mixed for 1 minute and poured in to the molds. Plastic cylinder molds of 2 inches in diameter and 4 inches in height were used. Each mold had 4 wires installed to measure the electrical resistance.

4. Result and Discussion
As shown in Fig.1 adding 4% oil increased the initial resistivity by 30%, adding 10 metakaolin increase resistivity by 35% and the mix had the combination of 10 % metakaolin and 4% oil increase the initial electrical resistivity of the cement by 65%. From the Fig.2 it can be observed that control specimen with 1.8 ksi showed highest compressive strength and the mix with 4% oil contaminated showed the lowest compressive strength of 0.65 ksi. Adding 10% metakaolin to the mix had 4% oil increased its compressive strength up to 1.32 ksi. Both the control specimen and specimen made with 10% Metakaolin and 4% oil inside showed the fractional change in resistance ($\Delta R/R_o$) of about 0.5, while specimen made with the 4% oil, reduced it to 0.1 at the failure point.

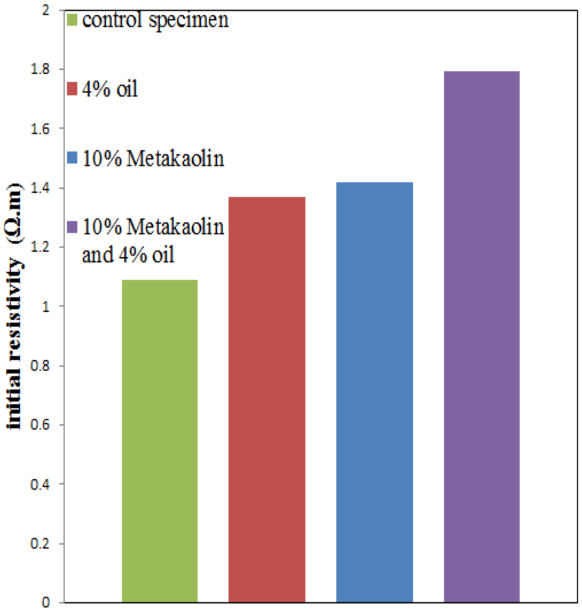

Fig.1. initial resistivity versus time

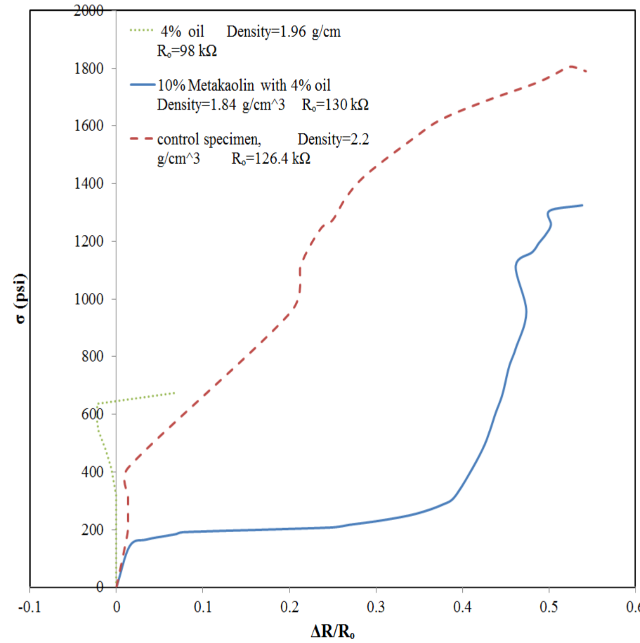

Fig.2. Compressive strength versus fractional change in electrical resistivity

5. Conclusion

Resistivity can be used as a measurement to detect the contamination in the oil well. Also oil prevented the cement from gaining strength and reduced its 2 days compressive strength up to 65%. Addition of 10% Metakaolin lowered this reduction by 27%. Also addition of oil as a contamination reduced the sensing ability of cement mix, as it can be seen fractional change in resistance at failure for slurry with and without oil was 0.1 and 0.5 respectively, while addition of 10 % metakaolin to contaminated sample increase it to 0.5.

6. Acknowledgement

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7. References

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