The Effect of Metakaolin and Sodium Silicate on the Electrical Resistivity and Thermal Conductivity of Modified Oil Well Cement

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Abstract: The effect of Metakaolin and sodium silicate as additives to modify the oil well cement was investigated at room condition. For this purpose 5 and 10% Metakaolin, 0.5 and 3% Sodium Silicate by the weight of cement was added. It was observed that 10% Metakaoline decreased thermal conductivity by 3.8% and increased initial electrical resistivity by 24% .Additional of 3% sodium silicate decreased electrical resistivity by 90.7% and the thermal conductivity by 8.7% compare to control sample.

1. Introduction:

Hydration of cementations material is an important process for developing the mechanical strength. Cement hydration has been monitored in so many different ways by Vicat needle, strength, scanning electronic microscope (SEM), X-ray diffraction (XRD),[1, 2] Chemical reaction between water and the anhydrous compounds of the cement during hydration result in highly connected slurry. As a result, cement hydration can be monitored by means of changes in its electrical resistivity. Metakaolin (MK) is an artificial pozzolonic material in cement which is produced by burning selected kaolinite clay within a specific temperature range (between 650 and 800 °C)[3].On the other hand, sodium silicates are used as extenders and set accelerators.

2. Objective:

The overall objective was to investigate the effect of metakaolin and sodium silicate on the electrical resistivity and thermal conductivity of modified oil well cement at room condition.

3. Materials and Methods:

Mixing was done in 3 steps: mixing water with metakaolin for better dispersion. After adding cement to the slurry sodium silicate was added and mixed with the slurry. API Class H oil well cement was used in this study. The cement mix was then placed in plastic cylinder mold of 2 inches diameter and 4 inches height. Each mold had 2 wires which installed to measure the electrical resistance.

4. Result and Discussion:

As shown in fig.1, thermal conductivity decreased with curing time while electrical resistivity increased at higher rate. In fig.3, it is obvious that addition of 3% of sodium silicate decreased electrical resistivity 90.7% comparing to control sample from 0.78 to 0.41 Ω.m. Adding 10% metakaolin, regardless of the amount of Sodium Silicate, decreased thermal conductivity from 0.806 to 0.775 W/(m·K).A linear relation was observed between thermal conductivity and electrical resistivity after initial setting.

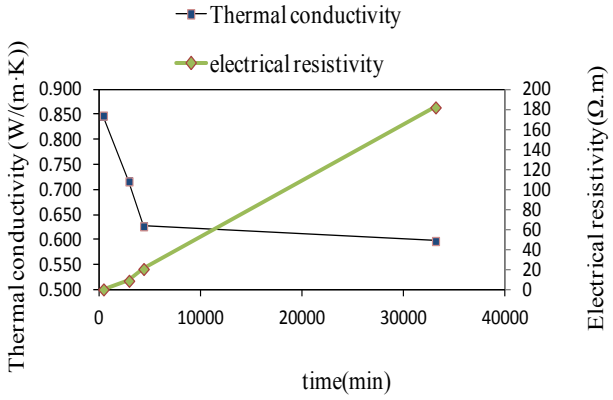

Fig.1. Thermal conductivity and electrical resistivity of 5% Metakaolin & 0.5%Sodium silicate during curing time

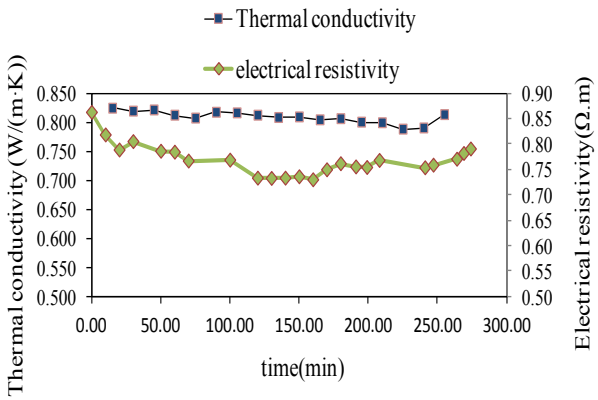

Fig.2. Thermal conductivity and electrical resistivity of net cement during first hours

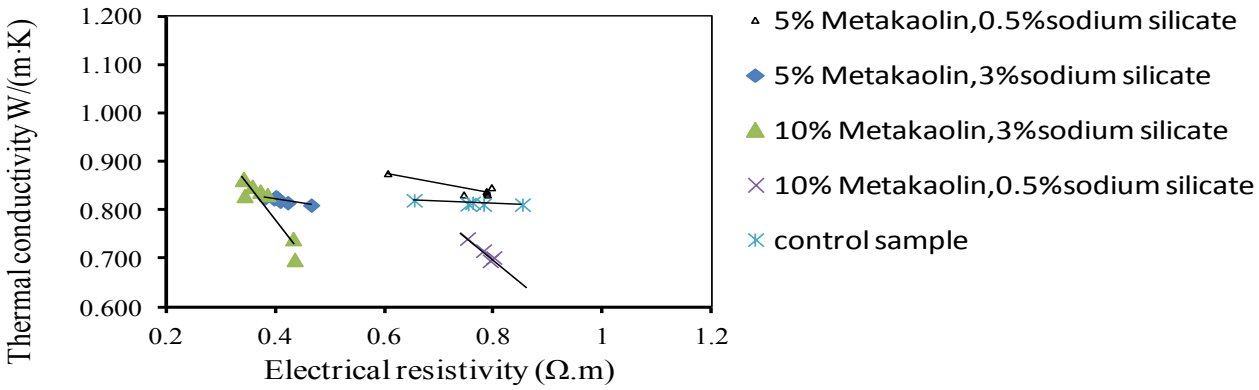

Fig3. Relation between thermal conductivity and electrical resistivity of cement with different percentage of additives.

5. Conclusion

Metakaoline is a suitable additive for high temperature applications such as oil well. High percentage of Sodium Silicate reduces electrical resistivity which makes the cement less sensitive

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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