

Effect of UH-Biosurfactant on the Smart Oil Well Cement Hydration and Piezoresistive Behavior

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Abstract:

UH-biosurfactant was used in smart piezoresistive class H oil well cement. Addition of 1% UH-biosurfactant reduced the hydration temperature of the cement by 17.6 °F (11%) and increased the resistivity during hydration and improved the piezoresistive behavior.

1. Introduction

Oil well safety is a major concern during well completion and well operation. With temperature going up to 200 °C, lower heat of cement hydration is preferred (Ramachandran 1995). This normally is achieved by blending additives into the cement. Monitoring the long term behavior of the cement is also necessary to reduce risks of cement failure. Electrical resistivity is a good parameter, especially for piezoresistive cement (Han et al. 2012). Surfactant is normally added to the oil well cement as a dispersing agent, retarding agent, water reducing agent, and foaming agent (Nelson 1982; Schlumberger Materials Handbook). Compared to widely used chemical surfactants in oil well cement, usage of biosurfactant has not been reported in the literature. Biosurfactant has higher biodegradability and lower toxicity compared to chemical surfactants. UH-biosurfactant was produced from used vegetable oil, which makes it more cost effective.

2. Objective

The overall objective was to investigate the effect of UH-biosurfactant on hydration and piezoresistive behavior of smart oil well cement.

3. Materials and Methods

A class H oil well cement (API class H-high sulfate resistant) was used in this study. The cement was mixed with 0.075% of conductive fiber. UH-biosurfactant (1%) was dissolved in tap water and then mixed with the fiber added cement. The specimens were cured in a 3.5 inch long, 1.5 inch diameter cylinder, and two wires were buried into the specimen. The specimens were demolded after 3 days at room temperature. The piezoresistive behavior was tested by measuring resistance change under compressive stress. Change of nominal resistivity was obtained based on the change of resistance. During its early hydration, the change of impedance of the cement samples were tested at 10 kHz for every 15 min by electrochemical impedance spectroscopy (EIS) device (Gamry). Temperature change during its early hydration process was recorded using a calorimeter (Calmetrix). Duplicate specimens were tested under each condition.

4. Results and Discussion

Addition of biosurfactant reduced the hydration temperature from 171.7 °F to 152.2 °F (by 11%). The time to reach the peak temperature was slight changed from 20.7 to 21.4 h. This indicated the effect of the biosurfactant to reduce heat of cement hydration without interfering the setting time of the cement. Our previous study showed that frequency of 10 kHz minimized the contact resistance and other polarization effect. Addition of the biosurfactant enhanced the resistance during hydration process from 0.64 kΩ to 0.69 kΩ, a 7.8% increase. Addition of biosurfactant improved the piezoresistive behavior of the cement. Addition of UH-biosurfactant increased the piezoresistivity at failure in compression from 60% to 80%.

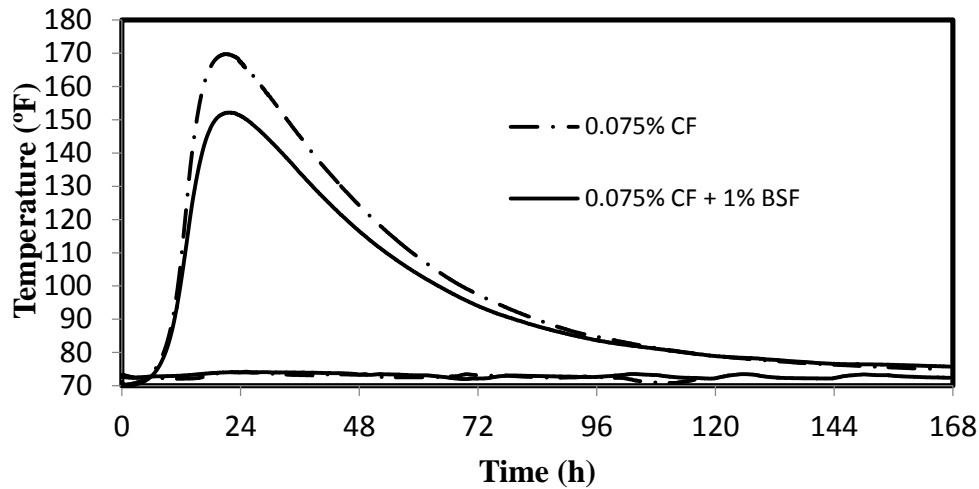


Fig.1 Temperature Change during Modified Oil Well Cement Hydration with or without Biosurfactant

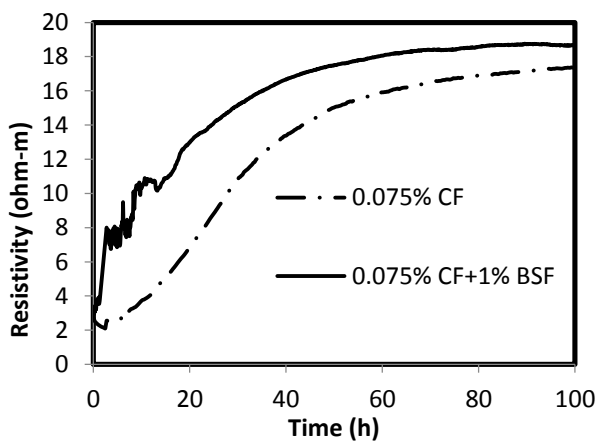


Fig.2 Resistivity Development during Modified Oil Well Cement Hydration with or without Biosurfactant (10 Hz)

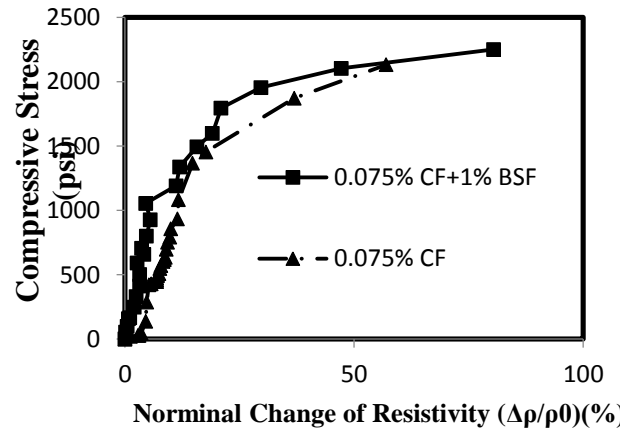


Fig.3 Piezoresistivity of Modified Oil Well Cement under Compressive Stress with or without Biosurfactant (DC)

5. Conclusions

UH-biosurfactant showed great potential for application in oil well field to reduce heat of hydration of the cement. Addition of UH-biosurfactant increased the resistivity of cement during hydration and improved the piezoresistive behavior of the cement.

6. Acknowledgements

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7. References

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