Effect of Nano $CaCO_3$ on the OBM Contaminated Smart Cement

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Abstract: The effect of adding 1% Nano CaCO3 (NCC) on Smart cement which was contaminated with 3% of OBM was evaluated. Modification of smart cement with NCC increased the initial resistivity of the OBM contaminated smart cement. It also accelerated the hydration process of the smart cement which was delayed by OBM contamination. NCC enhanced the piezoresisitivity and compressive strength of OBM contaminated smart cement.

1. Introduction:

Proper cementing is critical to ensure the integrity of the wellbore during the installation and entire service life. Poor cementing can contribute to the loss of zonal isolation between the casing and natural geological formation. Before the cementing operation, drilling fluid system should be used (Guerrero, 1998). Among the drilling fluids, oil-based drilling mud (OBM) is popular with deeper formation. The significant benefit of OBM compared to water-based mud is its ability to enhance the stability of the hole, higher lubrication of the drilling tools, more protection of oil formations and also reducing the corrosion problems (Erickson et al., 1988). While cementing, contamination of the cement slurry with remaining OBM in the casing-hole annulus will affect the hydration of the cement and also hardened cement. In this study, the effect of adding 1percent of nano $CaCO_3$ (NCC) on the smart cement was investigated in order to protect the smart cement against oil based mad (OBM) contamination. Recent researches showed the effect of NCC on compressive and flexural strength enhancement of cementitious material (Liu et al., 2012).

2. Objective:

The overall objective of this study was to investigate the effectiveness of 1% NCC additive in the smart cement to protect against OBM contamination.

3. Materials and Methods

The test specimens were prepared following the API standards. API class H cement was used with water-cement ratio of 0.38. For all the samples 0.075% (By the weight of total, BWOT) of conductive filler (CF) was added to the slurry in order to enhance the piezoresistivity of the cement and to make it more sensing. The smart cement slurry was mixed with 1% NCC and then contaminated with 3% OBM. Mineral oil was used to prepare the oil-based mud with oil to water ratio of 4:1 with the addition of 1% (By the weight of total, BWOT) of chemical surfactant. After mixing, the slurries were casted into the cylindrical molds with height of 4 inches and diameter of 2 inches, in which, two conductive wires were embedded 2 inches far from each other in order to monitor the resistivity development of the specimens during the curing time and also to measure the piezoresistivity of the specimens.

4. Result and Discussion

The average initial resistivity of the cement slurry was 1.07 Ω.m. Contamination of the cement 3% OBM resulted in an increase in initial resistivity of 1.42 Ω.m to 33% increasing. Addition of 1% of NCC decreased the initial resistivity of 3% OBM contaminated cement by 25%, from 1.42 Ω.m to 1.06 Ω.m. The compressive strength of the cement without any contamination or modification was 1.20 ksi after1 day of curing. 3% of OBM contamination decreased the compressive strength to 0.67 ksi, a 44% reduction after 1 day of curing. Adding 1% of NCC increased the compressive strength of 3% OBM contaminated smart cement by 72% to 1.16 ksi after 1 day of curing. Piezoresistive behavior of smart cement was evaluated after 1 day of curing under water. After 1 day of curing, the piezoresistivity of the smart cement was 375%. 3% of OBM contamination with smart cement reduced the piezoresistivity to 231%, a 38% decrease. Adding 1% of NCC caused the piezoresistivity of the contaminated cement with 3% of OBM enhanced by 38% to 319% piezoresistivity after 1 day of curing under water. This increasing in piezoresistivity is due to enhancement in the microstructure of the smart cement with adding 1% of NCC.

Table 1. Electrical resistivity parameters of the modified and unmodified smart cement slurries with NCC which were uncontaminated or contaminated with 3% of OBM

Cement	ρ_0 $(\Omega.m)$	ρ_{min} $(\Omega.m)$	t_{min} $(minute)$	ρ_{24} $(\Omega.m)$	$\frac{\rho_{24}-\rho_{min}}{\rho_{min}}$ –
Smart Cement					
Uncontaminated cement	1.07	0.95	85	2.86	201%
3% OBM contaminated cement	1.42	1.18	120	1.89	84%
1% NCC Modified Smart Cement					
Uncontaminated cement	0.85	0.77	60	4.02	341%
3% OBM contaminated cement	1.06	1.02	90	2.29	125%

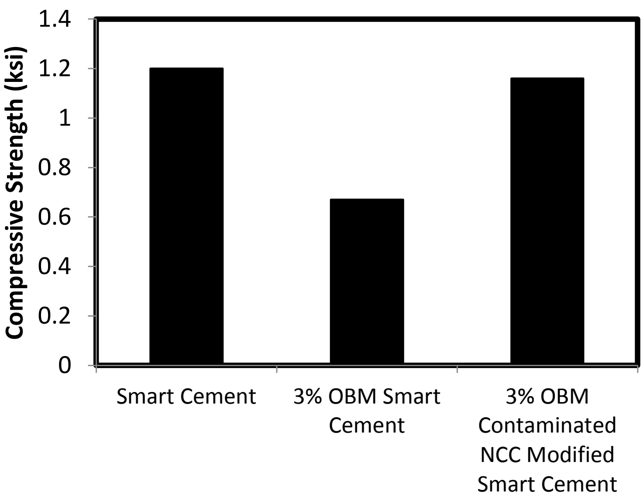

Figure 1. Compressive strength development of 3% OBM contaminated smart cement with and without 1% of NCC modification after 1 day of curing

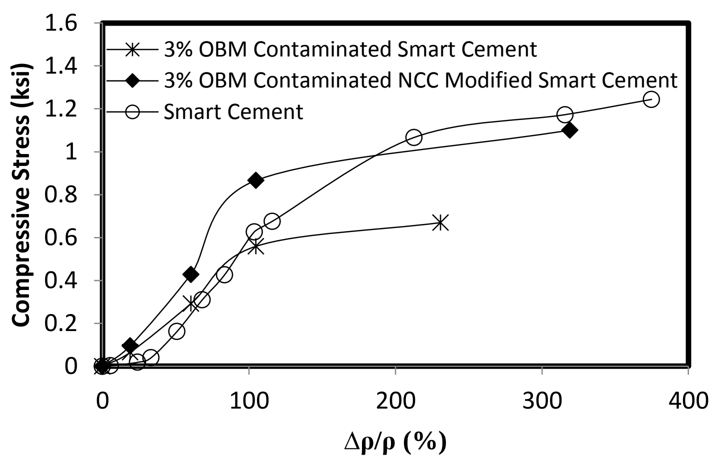

Figure 2. Piezoresistivity behavior of 3% OBM contaminated smart cement with and without 1% of NCC modification after 1 day of curing

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7. References

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