Behavior of Nano Calcium Carbonate Modified Smart Cement Contaminated with Oil Based Drilling Mud

Research Themes

Production is expanding in oil and gas around the world; hence, there are challenges in well construction. There are several benefits in using oil based drilling mud (OBM) in drilling operations especially in shale formations, but there are concerns about the potential contamination of the cement. Recent case studies on cementing failures have clearly identified some of these issues that resulted in various types of delays in the cementing operations. At present there is no technology available to monitor cementing operations and also to determine the potential of contamination in real time during the installation of the oil and gas wells.

In this study, the effect of adding up to 1percent of Nano $CaCO_3$ (NCC) to the smart cement was investigated in order to protect the smart cement against oil based mud (OBM) contamination. Variation in the electrical resistivity of the smart cement with curing time was monitored from the initial time of mixing to 28 days of curing under water. Results showed that contamination of smart cement with OBM reduced the long term resistivity of the smart cement but adding NCC enhanced the electrical resistivity of the contaminated smart cement cured under water. In order to evaluate the piezoresistive behavior of the smart cement, 0.075 percent (BOWC) of conductive filer (CF) was added to the cement to enhance the piezoresistive behavior of the cement. Results showed that change in resistivity at compressive failure for the smart cement was over 1000 times more than compressive strain and addition of 1% NCC further enhanced it by about 37% after 1 day and 28% after 28 days of curing under water. The OBM contaminated smart cement showed less change in piezoresistivity at maximum compressive stress at failure than the smart cement but addition of 1% of NCC enhanced the piezoresistivity of OBM contaminated smart cement.

Recent Accomplishments

1. Hyperbolic model was used to model the rheological behavior of the cement slurry based on shear thinning behavior of the cement slurry with a limit on the ultimate shear stress.

2. Contamination of the smart cement slurry with OBM increased the initial electrical resistivity but the long term measurements showed reduction of electrical resistivity after 28 days of curing under water. This long term reduction was due to reduced hydration in OBM contaminated smart cement.

3. Modification of smart cement with 1% of NCC resulted in the reduction in initial electrical resistivity of the smart cement. Also this modification caused an enhancement in the long term electrical resistivity of the smart cement and also OBM contaminated smart cement which indicated higher hydration in the NCC modified smart cement.

4. NCC modification resulted in considerable improvement of compressive strength and piezoresistivy of OBM contaminated smart cement both after 1 and 28 days of curing under water.

5. The p-q model predicted the compressive stress-change in piezoresisty relationship of smart cement with any contaminations and/or modifications.

6. Using the changes in electrical measurements the other kinds of degradation such as carbon dioxide migration through oil well cement can be monitored.

7. Electrical measurements has been shown to be a sensitive method for monitoring any changes in the temperature or pressure in the oil wells.

Issues

Contamination of oil well cement can occur during installation or later due to any fluid leakage and probable gas migrations in the well bore. Hence, specifying the level of contamination on cement and monitoring the effects of it on the mechanical properties of the oil well cement are major issues. Also any kind of degradations can be sever due to high pressure and high temperature conditions in the deep oil well which should be take into account for having a better perspective of the contamination and as a result having a better solution for such degradations.

Niousha Amani

Major/Field of Study: Civil Engineering

College: Cullen College of Engineering

Professor: Dr. C. Vipulanandan

Email: newsha.amani@gmail.com

CIVE