Effect of Foam on the Fluid loss and Peizoresistive Properties of Smart Cement

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Abstract: In this study, the effect of foam on the fluid loss and peizoresistive properties of smart cement cured for one day were investigated. The results of fluid loss and piezoresistive properties for cement samples with different foam content are presented. Foam contents of 0%, 20% are investigated. Addition of 20% foam to the smart cement reduced the fluid loss from 134 mL to 13.7mL in 60 minutes, a 90% reduction. The compressive strength of smart cement was reduced to 220psi from 1300 psi, a 83% reduction and the peizoresistivity reduced from 450% to 180% with addition of foam.

Introduction

Cementing casing across highly depleted zones and weaker formations requires low-density cement systems capable of reducing the hydrostatic pressure of the fluid column during cement placement conditions. Foam cement is a light weight and thermal insulation material consisting of cement matrix with porosity structure created by injecting preformed foam into cement slurry during the mixing process [1]. Foam cement is defined as a cementitious material having minimum of 20 percent by volume of foam in the slurry in which air pores are entrapped. These cements are generally used in formations that are unable to support the hydrostatic pressure developed by conventional cement slurries.

Advantages of using foam cement compared to regular cement (Kopp et. al. (2007)):

- Low Hydrostatic Pressure: A reduction in density from 1.92 to 1.44 g/cc reduces hydrostatic pressure by 5.5 MPa or 400 psi.
- Imparts fluid-loss control
- High Ductility and bubble structure: Effective for thermal and mechanical loading
- High Viscosity: Mud Removal- High Bond values
- Stabilizes at high temperatures
- Has low permeability
- High tensile capacity
- Foam cement has atleast 20% foam by volume which reduces the amount of cement consumption thus making it green cement.
- Cement + Foam = Green → Foam Cement

1. Objective

The main objective was to quantify the changes in fluid loss and peizoresistive behavior of smart cement by the addition of 20% foam.

2. Materials and Method

Oil well cement of Class H was used for the formulation of the foam cement. A water to cement ratio of 0.38 was employed. Carbon Fibers of about 0.075% of weight of cement and water were added for the mix to enhance the sensing properties. Preformed foam was used in percentage of total weight of the slurry. API Fluid Press method was used for fluid loss. A pressure of 100 psi was used for room temperature. Compression testing machine was used for monitoring the piezoresisitve behavior.

3. Results and Discussion

The Fluid loss in the smart cement was reduced the addition of foam. Addition of 20% foam decreased the fluid loss (60 min) from 134ml to 13.7ml (Fig.1). The peizoresisitivity of smart cement was initially high compared to foamed cement for low compressive loads. From about 500 lb load foamed smart cement showed rapid increase in the peizoresistivity. This increase in the peizoresistivity was due to ductile behavior of the foamed smart cement. (Fig. 2)

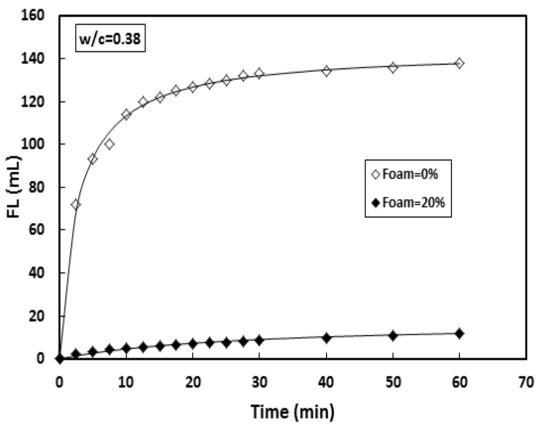

Figure 1. Fluid Loss in smart cement with addition of foam

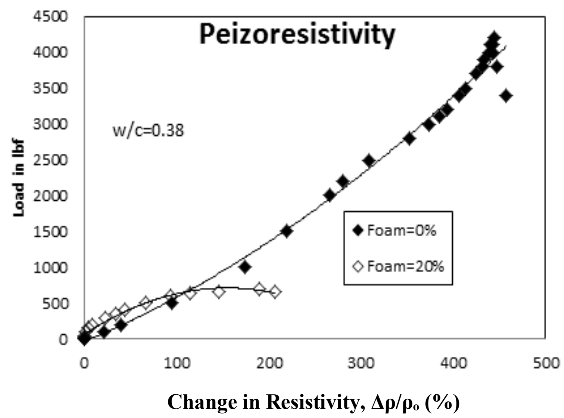

Figure 2. Peizoresitivity of smart cement with foam addition

5. Conclusion

Foam cement reduced the fluid loss by 90 percentage with the addition of 20% foam. Smart cement showed peizoresitivity of about 450% while 20% foamed smart cement showed 180% peizoresistivity. The compressive strength of the smart cement reduced from 1300psi to 220 psi, 83% decrease.

6. Acknowledgements

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7. References

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