Monitoring of Smart Cemented Field Well

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Abstract
Smart cement sheath supporting the steel casing in the field was used to monitor the piezoresistivity characteristics. Applying a pressure of 20 psi showed a resistivity of over 2% showing the resistivity of the smart cement while the change in the strain was about 2×10^{-6}%.

1. Introduction

As an important element of the oil well, cement sheath, placed in the annulus between casing and formation, provides zonal isolation and structural support to the casing throughout the life of a well (Goodwin, 1997). It must withstand high stresses under extreme service conditions and also should maintain the integrity of the oil well (Ravi, Bosma, and Gastebled, 2002). Hence knowledge of the cement properties during and after cementing is very important. Several methods have been used to monitor the behavior of cementatious material such as X-ray diffraction, calorimetric analysis, scanning electron microscopy and ultrasonic methods. Electrical resistivity is one of the method can be used to investigate the behavior of the oil well cement (Vipulanandan, Heidari, Qu, Hughes, and Farzam, 2014) due to the accuracy, ease of testing and nondestructive characteristics (Li and Wei, 2003) of this method. Piezoresistivity is an effect of stress-induced resistivity change of a material (Y. Sun, et. al, 2010). Piezoresistive-based applications are sensitive to phenomena that cause material to deform, and this deformation can be measured by resistance change. In other words, an electrical resistor will change its resistance when it is subjected to a strain (deformation).

2. Objective

The objective of this study was to test the piezoresistivity of the smart cement in the field well installed 10 months ago and also to capture the change in deformation of the smart cement using strain gauges.

3. Results and Discussion

For the first time, the real smart cemented wellbore was built in the Energy Research Park (ERP) in University of Houston. The depth of the wellbore is about 37 feet while the water table was located 25 feet below the ground level. The change in the cement resistance was monitored in 15 levels. The pressure was applied trough a pipe with 1.5 ft height located 5 feet below cement level (Fig. 1). Fig. 1 shows the resistivity changes up to 1.5% and 2.4% in the smart cement by applying pressure 10 psi and 20 psi, respectively. The vertical and horizontal strain gauges are located in 3 levels and the measurements are shown in the Fig. 2. The strains changed up to 4×10^{-6}% for vertical and 6×10^{-6}% for horizontal gauges.

4. Conclusion

The smart cement sheath was acting as a bulk sensor represented to the applied pressure of 10 psi and 20 psi with a change of resistivity of 1.5% and 2.4%, respectively. The change in the axial strains were very small and were of the order of 10^{-6}% strain.

5. Acknowledgments

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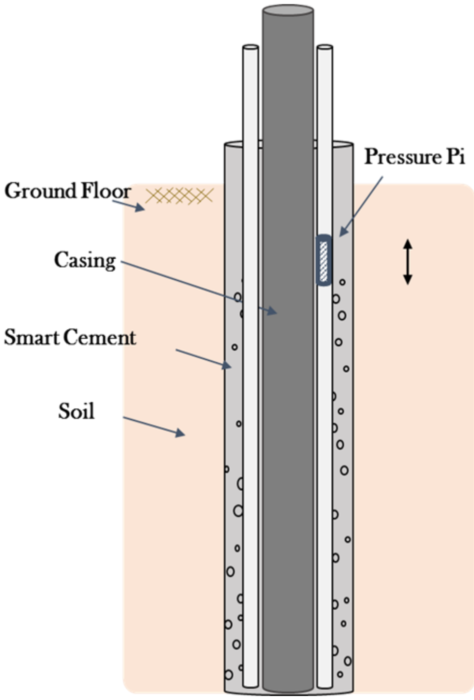

R_o
352.3
274.4
109.4
106.6
92.8
131.6
152.8
89.8
54.4
45.06
67.6

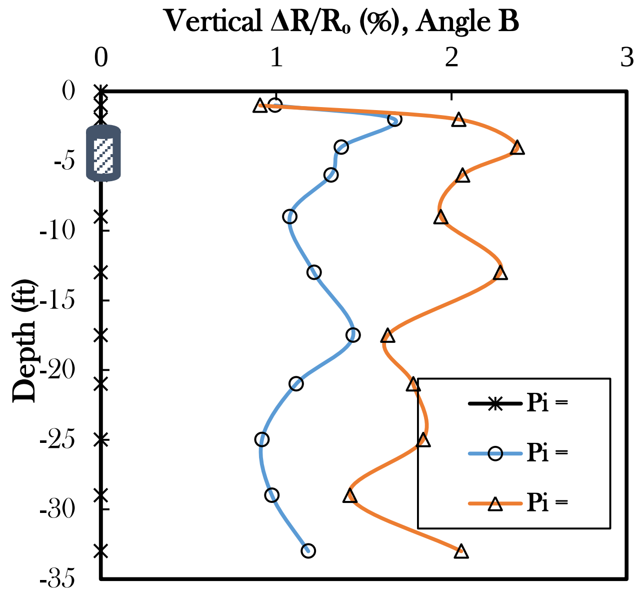

Figure 2. Resistivity changes due to pressure

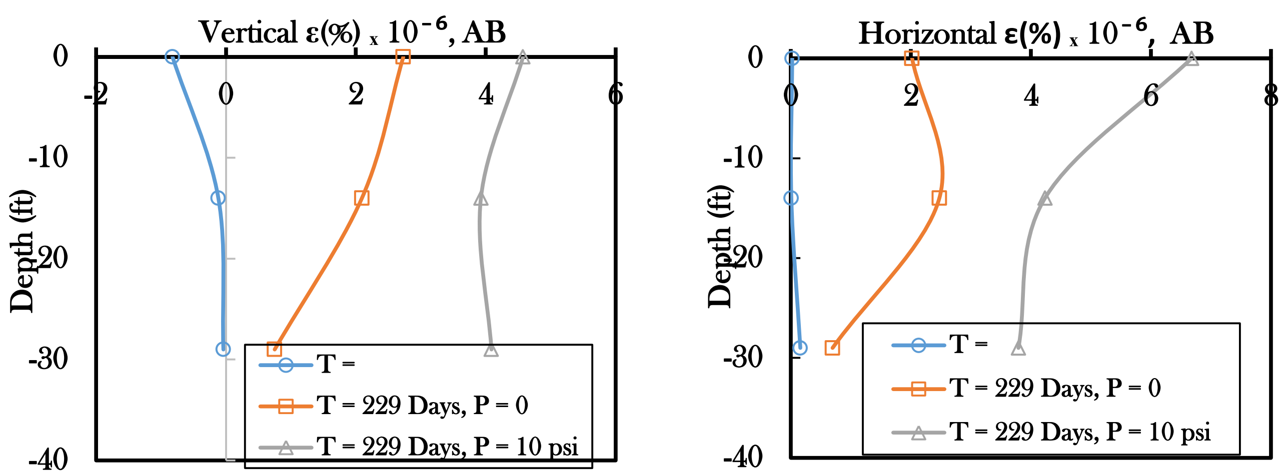

Figure 3. Strain changes due to pressure

6. References

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