# Resistivity Behavior of Oil Well Cement during Curing

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**Abstract:** Since oil well cement is used thousands of feet below ground, it is difficult to determine the setting time of cement using conventional methods. Hence oil well cement with water to cement ratio of 0.4, was modified using an admixture. The initial resistivity was 147 Ω-m and it changed to 1095 Ω-m after the cement hardened after 20 hours. And the electrical resistivity changed with the curing of the cement

## 1. Introduction

Oil well cement defined as the product obtained by pulverising clinker consisting essentially of hydraulic calcium silicates to which no additions other than calcium sulphate or water, or both, shall be interground or blended with clinker during the manufacture of the cement (World cement, 1992). Cement slurries are used in oil and gas wells for cementing the steel casing to the wellbore and thus sealing the rock formations from the well (Skalle, 1998). Cement with admixture added will have modified tensile and flexural properties, low drying shrinkage, high specific heat, low thermal conductivity, high electrical conductivity, high corrosion resistance, weak thermoelectric behavior, and good radio-wave reflecting and absorbing properties (Bao-guo, 2008). So determining cement setting time is practically difficult as the cement slurry will be placed in ultra-deep water applications.

## 2. Objectives

To modify the oil well cement to be more sensing by changing the electrical resistance during setting.

## 3. Materials and Methods

**Table 1: Class H Cement Components by Weight (Zhang, 2010)**

| | $C_3S$ | $C_2S$ | $C_3A$ | $C_4AF$ | Gypsum | Surface area ($m^2/g$) |
|---|---|---|---|---|---|---|
| Class H | 63.94 | 15.84 | 0.57 | 11.33 | 1.8 | 1.00± 0.0075 |

The Vicat setting test (ASTM C191) was used to determine the initial and final setting times for hydrating cementitious mixtures. It measures the change in the penetration depth of a plunger with a diameter of 1.13±0.05 mm under a constant applied load (300 g) as increasing structure formation acts to reduce the extent of penetration into the specimen. The test identifies initial and final setting at penetration depths of 25 mm and 0.5 mm respectively. The initial and final setting time are found to be 6 hours and 7 hours respectively for water-cement ratio of 0.4 (Zhang, 2010).

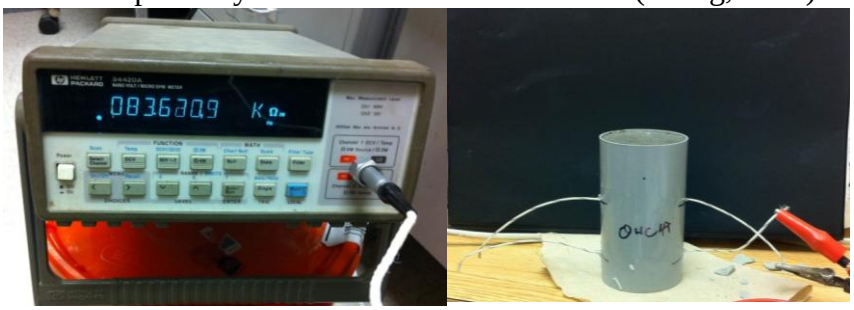

**Figure 1: Ohm-Meter with Oil Well Cement Specimen**

## Preparation Procedure:

(i) Class H Oil well cement was mixed with water with water to cement ratio of 0.4.
(ii) Admixture of 0.075% was added with the cement mix.
(iii) Cement, water and admixture was mixed using mechanical mixer for 3 minutes until the admixture is blended completely with cement slurry.
(v) The resistance was measured for 21 hours until cement was completely hardened (Fig.1).
(vi) Change in resistivity with time is shown in Fig.2.

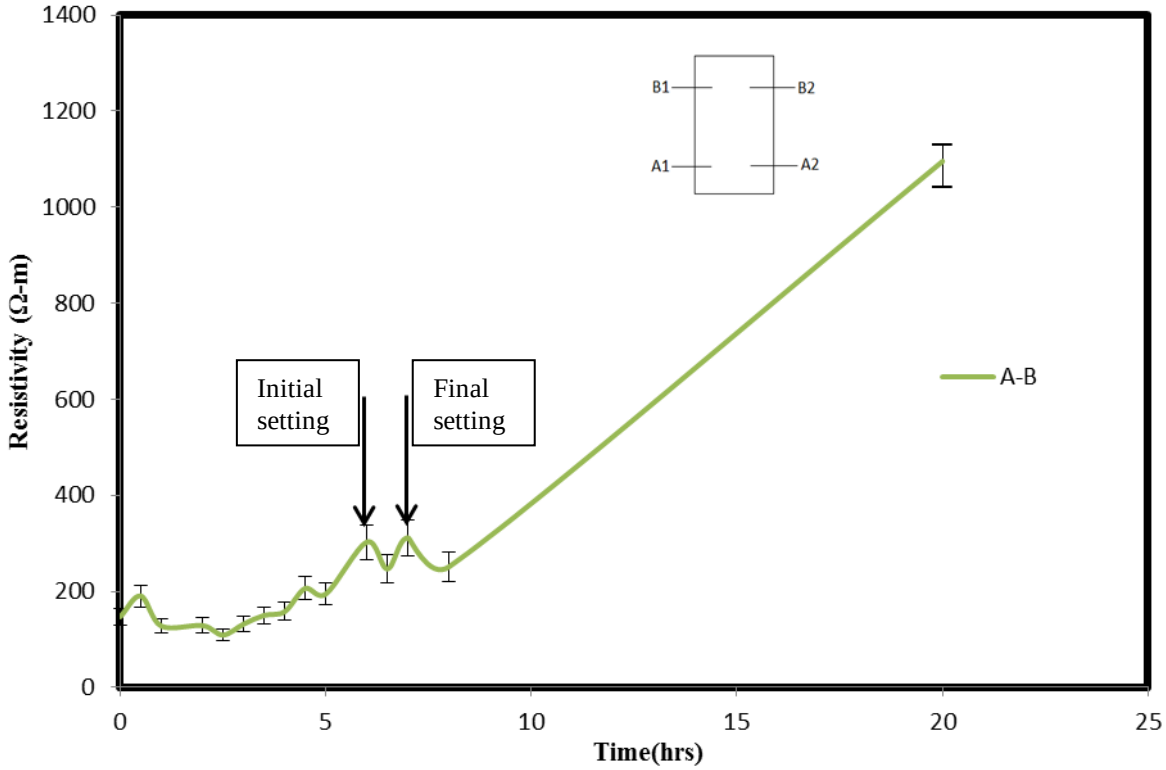


**Figure 2: Resistivity with Time with 0.075% of admixture**

## Discussion

As shown in Fig.2, the initial, final setting and cement hardening was indicated by the variation in resistance value. Initially the resistivity reduced but continued to increase thereafter. The resistivity increased by 4 to 5 times the initial resistance after the cement slurry completely hardened.

## 4. Conclusion

Initial and final setting is indicated by slight increase in resistivity and when the cement hardened 400% to 500% increase in resistivity value over the initial resistivity during setting was observed.

## 5. Acknowledgement

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## 6. Reference

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