Short Term Study of Salt Water Intrusion into Oil Well Cement

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Abstract: In this study, salt water intrusion into hardened oil well cement was investigated. Over a period of 28 days, the weight change was about 3% due to salt water intrusion.

1. Introduction

Sea water penetrates into oil well cement affects the properties of the oil well cement (Xingshan Zhou et al, 1996). Hence it is important to study the effect of salt water on oil well cement. In the literature, many models have been developed to predict chloride, sulfate as well as water diffusion into concrete and polymer concrete using Fick's second law or Nernst theory (Chatterji et al, 1995). So, this study aimed at the diffusion of salt water (containing 3% of NaCl concentration, which is similar to that of sea water) into modified oil well cement sample on a short term basis and analyzes the modeled values with the actual values.

2. Objective

Investigate the infiltration of 3% salt water into hardened oil well cement. Also compare the experimental results to a predictive model in the literature.

3. Methodology and Analysis

Three samples were prepared using class H cement with water to cement ratio 0.4 and 0.075% of admixture in standard cylindrical moulds (2'x4'). Samples were allowed to cure in air for 24 hours and then were immersed into salt water of 3% NaCl concentration for a period of 28 days. The weight change with time is shown in Figure 1. The average increase in weight within 24 hours was 1.5%.

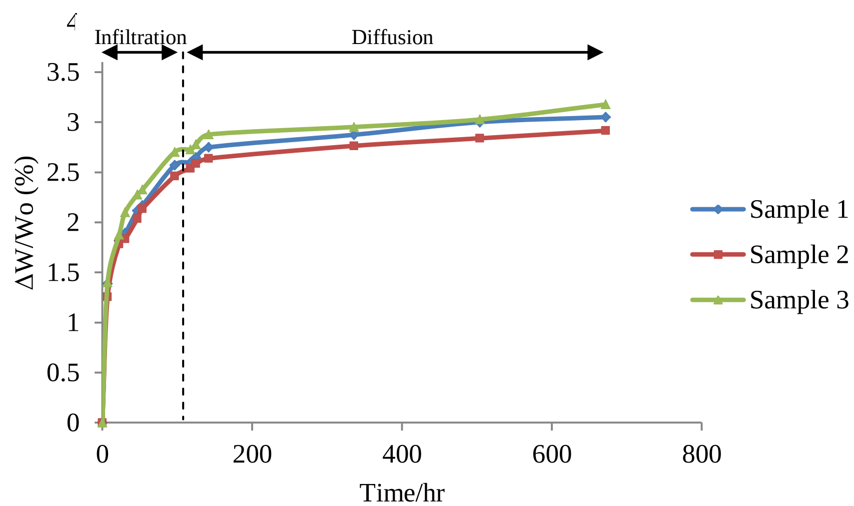

Figure 1. Percentage Weight Change with Time

Analysis

A model was developed to predict water uptake into polymer concrete by S. Mebarkia and C. Vipulanandan (1995) based on Fick's second law. The weight change with time [W(t)] was represented as follows:

$$M(t) = 2\pi h R^2 C_0 \frac{\lambda^b}{a}\left[1 - \frac{\lambda^b}{a} + \frac{\lambda^b}{a} exp\left(\frac{-a}{\lambda^b}\right)\right] \quad \text{.............................(1)}$$

Where, t immersion time;
h height of the specimen;
R radius of the specimen;
C_0 ultimate concentration of water in the specimen; and
a, b constants (a=0.04, b=1.72).

The term λ is given by the following equation where D refers to effective diffusion coefficient.

$$\lambda = \frac{Dt}{R^2} \quad \text{...(2)}$$

The models predictions are compared to the experimental results in Figure 2. In the cement specimens there was about 1.5% infiltration during the first day. Weight change after first few days appears to be more diffusion controlled.

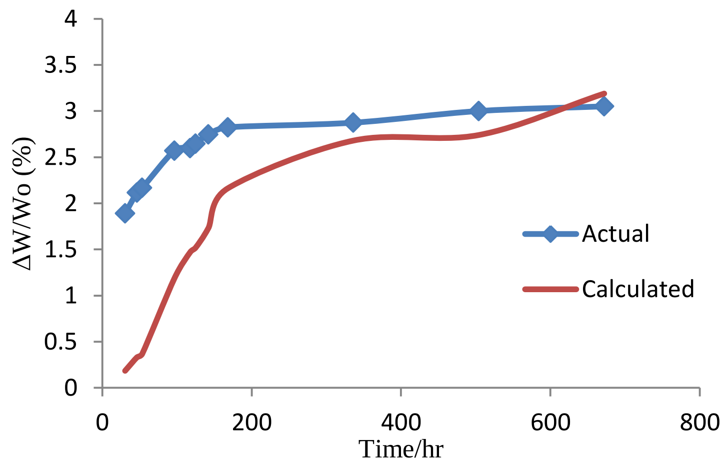

Figure 2. Variation of Actual Weight Change with Calculated Weight Change

4. Conclusion

During the first 24 hours, the cement specimens showed the highest change in weight of 1.5% due to infiltration. The weight change after 30 days of immersion was about 3%.

5. Acknowledgement

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6. References

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