Biological and Chemical Attack on Cement Mortar:
Leaching and Mechanical Properties

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Abstract
The durability of cement mortar in biological active solution and acetic acid was investigated in this study. The attack on cement mortar was monitored by changes in weight change, solution pH, specific resistance, compressive strength, and ions detected in solutions.

1. INTRODUCTION

Numerous studies showed that cement mortar is not durable in strong inorganic acids. Only limited information is available regarding the durability of cement mortar in acetic acid, fatty acid, and biological active environments. Moreover, most acid attack studies focused on the influence of the acid type, pH, and water/cement ratio. The lack of standard methods to access the deterioration makes it difficult to correlate the results of the studies in the literature. There is a need to develop techniques to characterize deterioration of cement mortar in wastewater environment.

2. OBJECTIVE

The overall objective was to investigate the chemical durability of cement mortar in biological active environment and organic acid. Specific objectives are (1) to investigate the durability of cement mortar in acetic acid and biological active solution; (2) to analyze the leaching solutions to determine the type and quantity of ions leached from cement mortar; and (3) to determine the relationship between physical/mechanical properties and type of element leached.

3. TESTING PROGRAM

Cement mortar. Ordinary Portland cement (OPC) and ASTM C 33 sand were used to prepare samples. The cement-to-sand ratio and water-to-cement ratio used to prepare cement mortar samples were 1/6 and 0.5, respectively. Specimens were cast in Teflon moulds (38 mm in diameter and 80 mm in height). After 28-day curing, specimen was removed from bag and recorded for its weight, length, and diameter before the test.

Reactor setup. Solutions of DI Water, 1% acetic acid, and biological active solution fed with 1% vegetable oil, respectively, were prepared in separate reactors and the cement mortar specimen were fully immersed. In all cases, samples were stored in sealed bottles and kept at room temperature for different period time before making property measurements. The volume of the solution used was 600 mL per reactor.

Measurements. After the specimens were removed from the test solutions, specimen and solution properties were measured. Parameters such as weight, dimensions, pulse velocity, solution pH, and oxidation-reduction-potential (ORP) were measured. The unconfined compressive strength (UCS) of sample was determined according to ASTM D2166. Calcium and iron ions leached out from cement mortar sample were quantified by using an atomic absorption spectroscopy (Perkin-Elmer).

4. RESULTS

Weight change. The weight change of concrete in DI water was about 1.3% during the 3-month test period (Fig. 1). For samples immersed in acetic acid and biological active solution, the maximum weight changes were 2.1 and 1.6 %, respectively. A linear relationship between weight change and square root of time was observed showing that diffusion was the main mechanism controlling the weight change.

pH changes. The pH was increased from 6.5 to 12.5 for samples immersed in DI water. For those immersed in acetic acid and biological active solution the pH increased from 2.5 to 8.5 and from 5.5 to 6.5, respectively.

Specific resistance. Results showed that samples immersed in acetic acid and biological active solution had a 63% and 28% reduction in specific resistance compared to those immersed in DI water.

(a) water (b) biological active solution (c) acetic acid

Figure 1. Cement mortar in various solutions after 3-month immersion.

5. CONCLUSIONS

(1) Diffusion was the main mechanism that contributed to the sample's weight gain during the immersion study. Among the solution, acetic acid had the highest diffusion constant followed by biological active solution and DI water.

(2) The immersion of cement concrete in organic acid reduced its UCS. Compared to samples immersed in DI water, the reduction in UCS observed for samples immersed in acetic acid and biological solution were 45% and 31%, respectively.

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7. REFERENCE

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