Milliken GeoPolymers – 201

Chemical Resistance & Microbial Induced Corrosion – Moderate Acidic Conditions

Milliken®

GeoSpray™ AMS

Corrosion Resistant Geopolymer System

Background

In sanitary sewers and other wastewater environments, the general corrosion mechanism of cementitious based materials is well known and widely documented. It is often referred to as Microbial Induced Corrosion or (MIC).

The process of MIC involves a 3 step mechanism:

- First, hydrogen sulfide gas (H_2S), commonly referred to as sewer gas, is released by the reduction of sulfates in the sewer effluent from anaerobic bacteria – generally living in a "slime layer" below the water line.
- Secondly, sulfuric acid (H_2SO_4) is formed on exposed surfaces through the oxidation of H_2S by aerobic *Thiobacillus* bacteria.
- Finally, the sulfuric acid reacts most often with $Ca(OH)_2$ found in many cements to form gypsum $CaSO_4{\cdot}2H_2O$ which is water soluble and will wash away.

The exact mechanism of attack in the final step will depend on the specific chemistry of the cementitious materials present. A schematic representation of the MIC environment is a sewer pipe is shown in Figure 1.

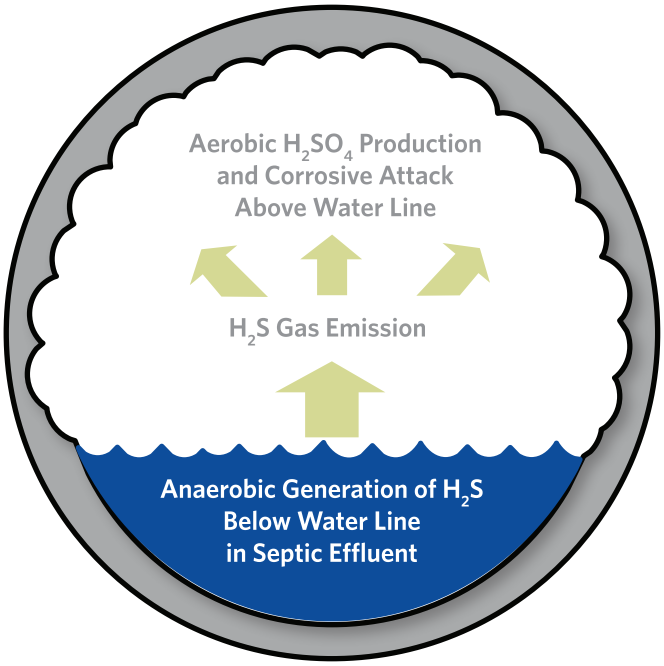

Figure 1. Mechanism of MIC

The GeoSpray™ AMS Advantage

The chemical make-up of GeoSpray AMS makes it inherently acid resistant to the MIC mechanism found in many sewer environments. Geopolymers (dependent on the exact formulation) will contain greatly reduced concentrations of $Ca(OH)_2$ (calcium hydroxide) essentially the acid corrosion mechanism found in many typical cements. In addition to the base geopolymer chemistry, GeoSpray AMS includes an added layer of chemical protection from the proprietary PostCoat that creates an additional glass-like chemically resistant surface.

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Testing

Chemical resistant studies were performed following the procedures of ASTM-C267. GeoSpray cubes were cast and then treated with AMS Post Coat and allowed to cure for 28 days before being soaked in both water and 1% sulfuric acid (pH 1.3).

Samples were measured for weight and dimensional changes after soaking for 1, 7, 14, 28, 56 and 84 days. 3 samples of the materials were soaked and tested, and the solution volume relative to the cubes was held constant. The chemical solutions were refreshed on day 14, 28, and 56. A picture of GeoSpray AMS cubes soaking in solution is shown in Figure 2.

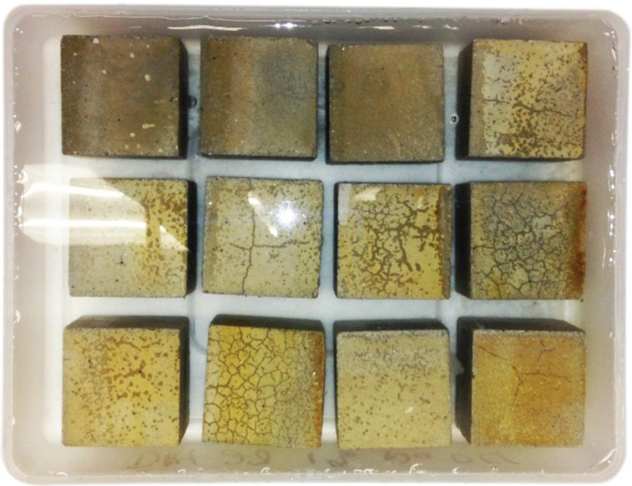

Figure 2. Cubes of the GeoSpray AMS system soaking in 1% H_2SO_4

Results

GeoSpray AMS samples showed almost no signs of chemical corrosion through the 84 days exposure to 1% H_2SO_4 (sulfuric acid). Figure 3 shows cubes with increasing duration of soaking after soaking from 0 to 84 days. The color and surface conditions of the samples were visually consistent through out the 84 days of exposure.

Figure 3. Cubes of the GeoSpray AMS system after soaking in 1% H_2SO_4

Figure 4 shows the effect of sulfuric acid on weight of the GeoSpray AMS cubes over the same time period. The results of weight are normalized to the percentage of weight change of samples soaked in water to account for the absorption of water. Through the 84 days exposure, no weight loss of material was observed within the error of the measurement.

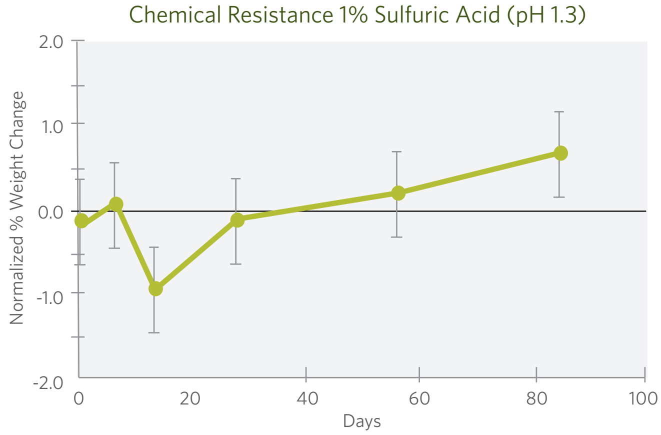

Figure 4. The weight change in the GeoSpray AMS system after soaking in 1% H_2SO_4

Conclusion

GeoSpray AMS when tested under the ASTM C-267 protocol against highly corrosive 1% sulfuric acid (pH 1.3) showed no measureable signs of chemical corrosion.

When looking for a material to repair corroded and structurally damaged sanitary sewer systems – look no further than GeoSpray AMS.

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