ConBlock**MIC**
Scientific Results

Concrete Sealants sponsored a university study to research the net effect of ConBlock MIC added to concrete. The study provided a great deal of new information, contributing to the existing body of knowledge garnered from previous research involving microbially induced corrosion of concrete and cementitious materials. The ConBlock MIC study utilized a laboratory accelerated chamber with environmental conditions nominally seven times more severe than what may be seen in the field as measured mass loss. Severe corrosion from previous research was defined at a pH measurement below 2.0, with most mass loss occurring at pH 1.0 and below. The ConBlock MIC research adds to the previous research findings by defining moderate corrosion at above 3.0 pH.

In a moderate corrosion environment, the concentration of hydrogen sulfide gas, H2s, is approximately 10-100 ppm. When the continuous concentration exceeds 100 ppm, the environment is likely to reach the severe level. Field readings of H2S in this study at a known corrosive sewer structure were between 0 and 80 ppm. Additionally, government research conducted on sewer systems throughout the United States confirms that the nominal H2S concentration is below 80 ppm.

Calcium aluminate cement (CAC) is widely used around the world as a protective cementitious liner in pipe and manhole rehabilitation. ConBlock MIC samples proved to provide as much protection in the MIC environment as CAC. In fact, the CAC cement treated with ConBlock MIC exhibited the least amount of mass loss during the moderate phase of the test. Additionally, concrete made with a blended cement (Portland + Fly Ash), and having ConBlock MIC added to the mix, also proved to provide the best protection. Conversely, the concrete made with blended cement without ConBlock MIC showed the most corrosion during this moderate exposure period.

Concrete containing ConBlock MIC proved to slow the rate of degradation in moderate exposure conditions. In addition, ConBlock MIC proved to neutralize the Thiobacillus bacteria when the culture environment measured greater than pH of 2.0. Throughout the testing, while the environment was within the moderate corrosion zone, all samples containing ConBlock MIC maintained a higher surface pH than any other samples, correlating to a longer product life cycle.

The ConSeal Difference

"We Work for
Our Customers"

Experience

ConSeal is a globally recognized company with warehouses and distribution in the U.S., Canada, and overseas. Since our inception in 1970, we consistently provide quick, reliable, first-rate solutions to meet the unique requirements of our producers and end-users worldwide. We continue to develop new and innovative products while providing exceptional technical expertise and premier customer service.

To learn more about ConBlockMIC please call 1-800-332-7325 to speak with a ConSeal technical representative.

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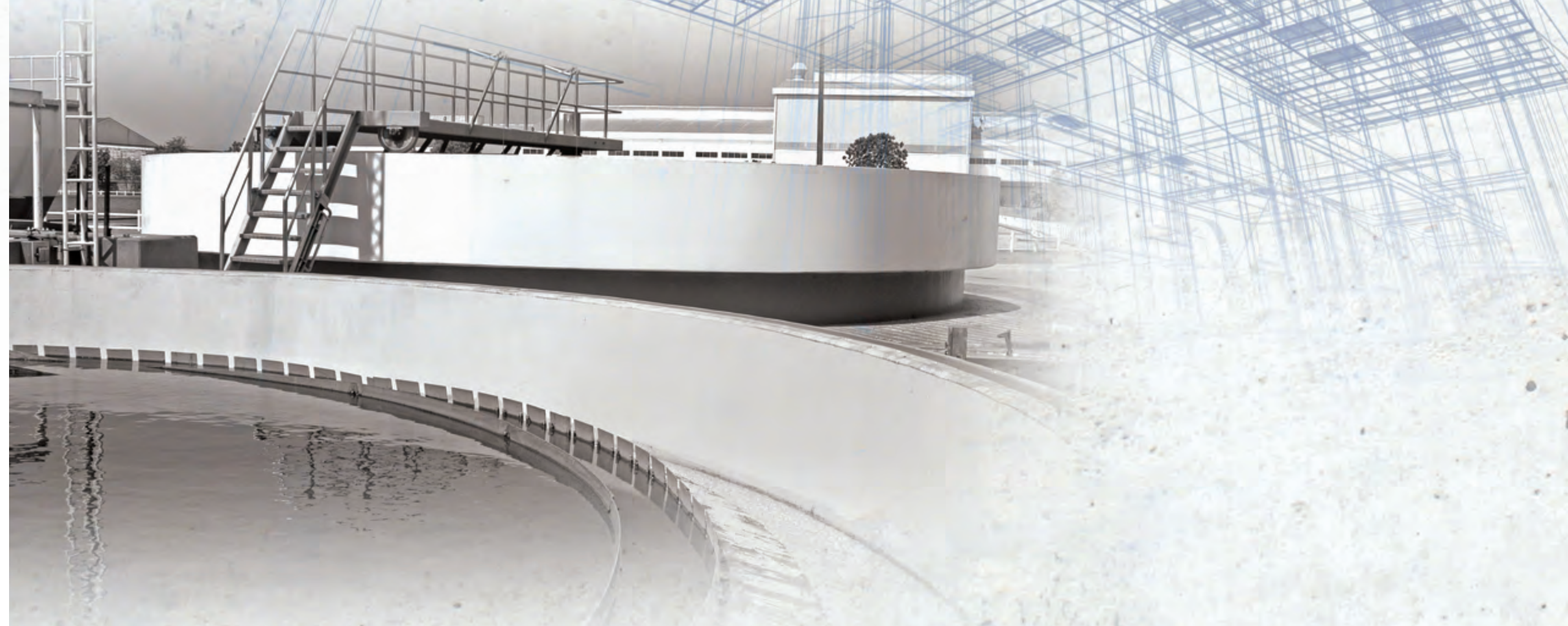
ConBlockMIC

SCIENTIFICALLY TESTED PROVEN



Antimicrobial Additive/Coating for Concrete & Cementitious Materials

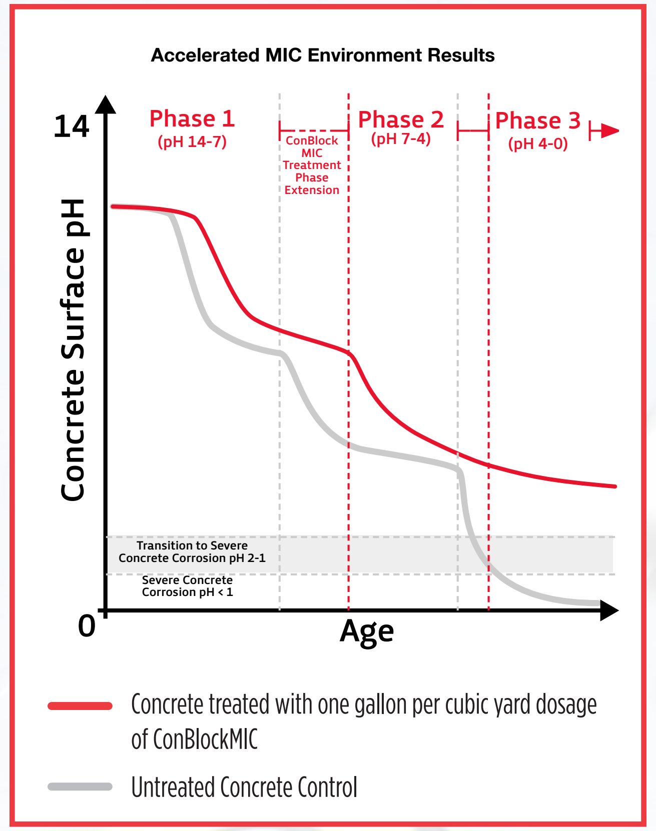
Scientifically proven to inhibit growth of:

Bacteria • Fungi • Mold • Algae

ConBlock**MIC**

Extending the service life of concrete structures

The performance history of underground infrastructure supports concrete's long and reliable service in wastewater systems. Concrete sewer pipes unearthed after centuries of use have been found in good condition. The sustainable and resilient attributes of concrete are why concrete is the most widely used product for wastewater systems worldwide. However, the alkalinity of concrete leaves it susceptible to an acid attack under unique biogenic conditions known as microbial induced corrosion, the process of microorganisms corroding concrete – most commonly found in concrete wastewater systems.



Accelerated[1] testing in an MIC environment over one year, with exposure to Thiobacillus bacteria and hydrogen sulfide gas, proves the difference in performance between untreated concrete and concrete made with the recommended one gallon per cubic yard dosage of ConBlock MIC.

[1] This controlled test environment was 7 times more potent than typical in field systems/installations.

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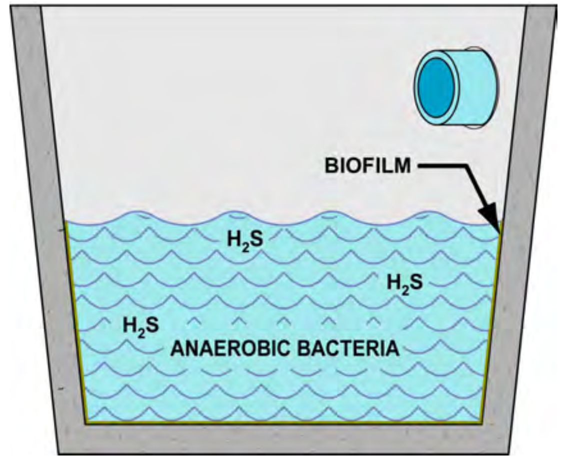
ConBlock**MIC**

The MIC Chain of Events

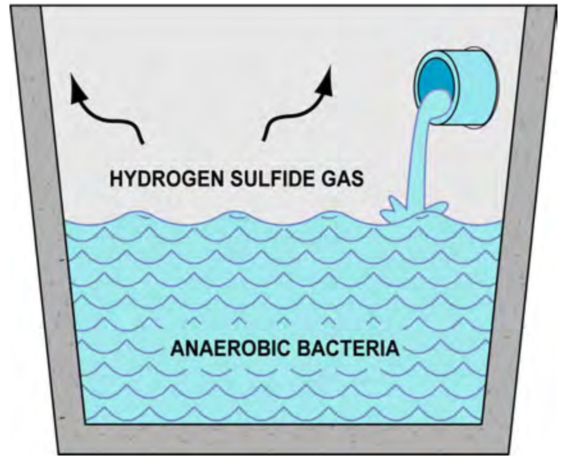
1

The 3 phases of MIC can be broken down into separate pH ranges of the concrete surface.
First phase: carbonating of the concrete surface starts immediately after production of the concrete. This natural process only needs to affect the thin layer at the surface to allow the start of phase two – the growth of a biofilm.

Transitioning from Phase 1 to Phase 2



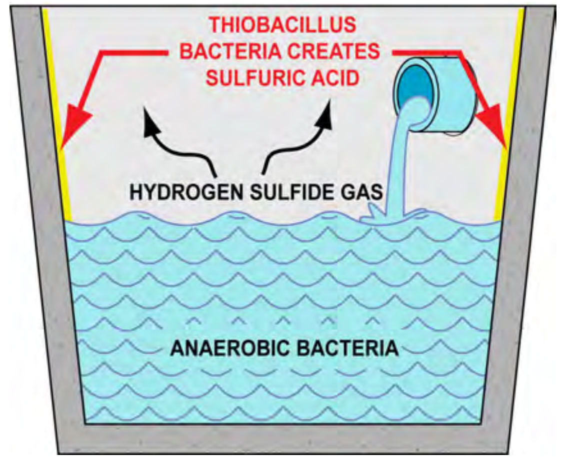
During the transition from phase one to phase two, the anaerobic bacteria convert sulfates into sulfides. These sulfides form hydrogen sulfide gas in the wastewater.



Formally in phase two, turbulence in the wastewater system releases hydrogen sulfide gas into the aerobic environment, which becomes valuable nutrients for Thiobacillus bacteria.

2

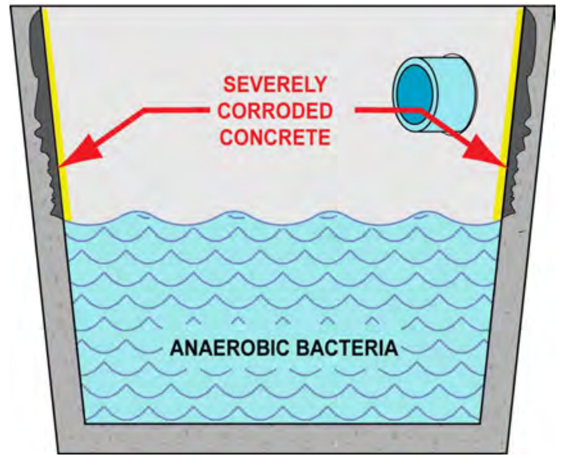
Phase two: the biofilm phase, provides the necessary colonization of organisms for harmful Thiobacillus to inhabit the concrete surface. The first species of Thiobacillus excrete weak acids by consuming available hydrogen sulfide gas and oxygen in the aerobic environment of the wastewater system. The excreted acid helps lower the concrete surface pH, enabling Thiobacillus species that produce stronger acids to inhabit the biofilm. This process continues well into phase three, where concrete deterioration occurs.



Thiobacillus can survive on concrete with a pH of 9 or lower. Turbulence releases hydrogen sulfide from the wastewater providing a source of food for the Thiobacillus.

3

Phase three: the deterioration phase of MIC, is only possible if phase two occurs. Starting around a pH of 4, habitation of Thiobacillus species that excrete stronger concentrations of acid begins the deterioration of the concrete surface. Severe corrosion occurs as the concrete surface pH drops below one. The damage occurs when the excreted sulfuric acid reacts with the free lime (calcium hydroxide) forming calcium sulfate, also known as gypsum. The gypsum reacts with the alumina in the concrete to form ettringite, which expands in the presence of moisture. This expansion causes the concrete to crack and spall, thus allowing for deeper penetration of acid and continuance of the damaging cycle.



Damaging levels of corrosion begin to occur when the concrete surface pH drops below 1.

Common environmental attributes for MIC to occur:

- Bacteria/Biofilm
- Low dissolved oxygen in wastewater
- Sulfates in the effluent
- Warm temperatures
- Turbulence
- Moisture on the walls above the waterline
- Reactive compounds in concrete
- Low effluent flow

How to tell if your system may have been a victim of MIC

MIC produces rough concrete surfaces showing loss of mortar or aggregates along with general spalling of the concrete. Damaged concrete surfaces can become soft to the touch, with missing aggregate and a gel-like texture at the concrete surface. One of the first indications of MIC is the appearance of a white mass above the waterline in a concrete wastewater system. This white formation is the gypsum formed in the reaction between the biogenic sulfuric acid and calcium hydroxide.

Example of MIC in a wastewater system.