Penetron BioMIC
Protecting concrete against the Silent Killer

Introduction

When we think of bacteria, most of us immediately think of the bacteria that attack the human body and make us sick. Our doctors prescribe medicines (antibiotics) to fight off these bacteria to bring us back to health. However, left unchecked, these bacterial infections make us sick, and they can even lower our immune system to the point that the bacteria itself kills us or makes us too weak for our body's natural defenses to protect itself.

The same concepts do not come to mind when we think about construction materials. And yet bacterial attack of steel and concrete are so prevalent, it costs billions of dollars in damage every year. Concrete is the most used construction material in the world; it forms the backbone of the world's infrastructure, not just in the construction we can see like bridges, dams and wastewater treatment plants, but also the unseen but equally important infrastructure of our underground sewage systems. When these underground structures are compromised, not only are the structures themselves at risk, but also the structures built on them, such as sidewalks, roads and buildings.

When unprotected concrete pipes and manholes in sewage systems are exposed to raw sewage, the concrete deteriorates rapidly, due to Microbial-Induced Corrosion, known as MIC.

MIC takes place when the non-air-breathing bacteria (anaerobic bacteria), which grows in raw sewage, is agitated by the flow of the sewage or inlet areas, causing it to form Hydrogen Sulfide Gas. This gas provides nutrition to the air-breathing bacteria (also known as Thiobacillus – a family of the aerobic bacteria) that is present on the surface of the concrete, resulting in the secretion of Sulfuric Acid. The Sulfuric Acid eats away the cement paste, causing the aggregate to be exposed and the concrete to deteriorate rapidly.

As the acid seeps deeper into the concrete matrix, it starts eating away the interior of the concrete, as well, and lowers the pH of the concrete, which destroys the protective alkaline passivating layer around the reinforcing steel. As a result, the reinforcing rusts, creating even more expansive damage to the concrete and ultimately undermining the sewer structures.

The acid does not only attack the concrete when it becomes gaseous in areas of low flowing air, it attacks metallic fixings within the sewerage system, such as embedded stairs, as well. This combination of deterioration results in increased maintenance and will eventually lead to structural failures within the sewage system.

Penetron BioMIC-treated concrete pipes and manholes in sewage systems are totally protected from MIC caused by the acid producing bacteria. By means of electro-physical destruction mechanisms, the bacteria cell walls are ruptured. If the bacteria are destroyed, acid cannot form

and, without the presence of acid, there will be no corrosion. This will result in Total Concrete Protection for the lifespan of the concrete.

Penetron BioMIC

PENETRON BioMIC is an antimicrobial admixture added to the concrete mix at the time of batching. It forms a molecular bond with the concrete, preventing microbial-induced corrosion damage and inhibiting the growth of other product-damaging and odor-causing microorganisms, such as bacteria, algae and fungi.

PENETRON BioMIC's technology is an EPA registered microbiostatic agent that ruptures microbe cell walls on contact. This complete electro-physical destruction of the microbes that come in contact with it does not deplete PENETRON BioMIC and, as it is also leach resistant and will not migrate through the concrete, it retains its effectiveness indefinitely.

Test Results

The main objective of the test was to show how Penetron BioMIC protects concrete against MIC. Concrete samples were treated with Penetron BioMIC and tested under modified ISO 22196 test methods to verify the antimicrobial efficacy of Penetron BioMIC against Thiobacillus bacteria compared to an untreated/control sample.

The samples were first subjected to an aging process to reduce their surface pH, creating a suitable condition for bacterial growth. The samples were ready for microbial tests after the surface pH was reduced to, and remained stable, in the range of pH 6.5 (+/- 0.5).

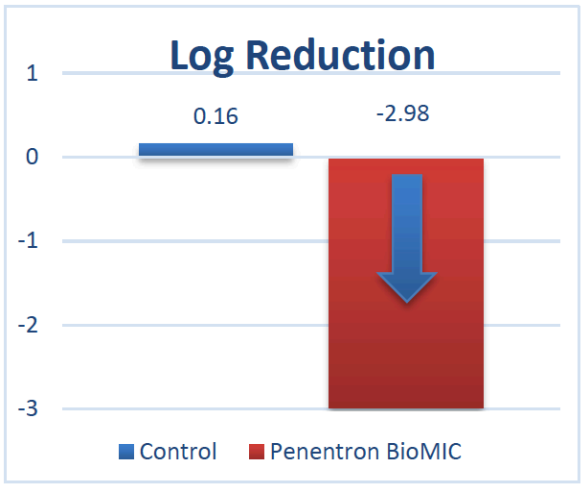
The Thiobacillus bacteria contains a wide range of species; in the test, Thiobacillus Novellus was selected for testing. Following the aging of the sample, the pH of the sample surfaces were confirmed to be approximately pH 6.5.

The samples inoculated with Thiobacillus Novellus were incubated for 24 hours, followed by recovery and plating of the micro-organisms from the sample surfaces. The table below contains the results from the tests.

Table 1: ISO 22196 Test Results

Sample Set	Interval	Result	
		Log Reduction	% Reduction
Control	24 hr	0	0
Penetron BioMIC-treated	24 hr	2.98	99.9

The test results show Penetron BioMIC-treated samples have a 2.98 log reduction (99.9% reduction) compared with untreated control samples.



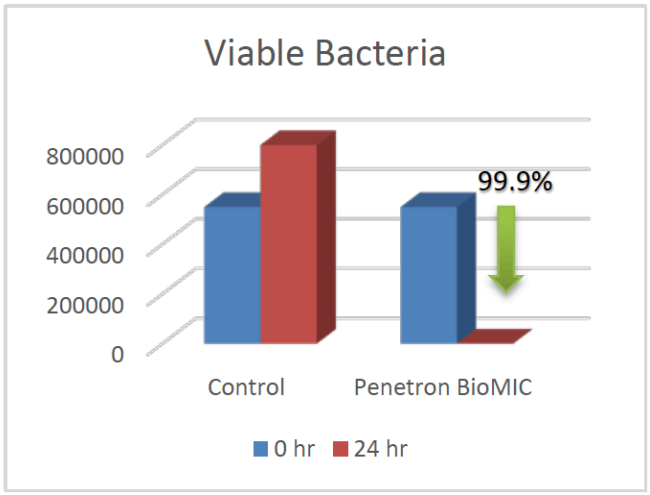


Figure 1(left) & Figure 2 (right): ISO 22196 Test Results

Conclusion

Penetron BioMIC-treated concrete prevents microbial-induced corrosion caused as a result of acid producing bacteria (Thiobacillus strain), by means of an electro-physical destruction mechanism, destroying the bacteria cell walls. Penetron BioMIC successfully kills 99.9% of the sulfur/acid producing, concrete eating bacteria within a 24-hour period. It also offers a broad spectrum of protection against fungi, mildew, algae, gram-positive and gram-negative bacteria.

Penetron BioMIC becomes an active and integral part of the entire concrete structure, so it remains effective even if the surface is abraded. Repeated contact will not lessen Penetron BioMIC's effectiveness either.

Adding Penetron BioMIC to all concrete used to construct pipes and manholes in sewage systems will result in Total Concrete Protection, ensuring a longer concrete lifespan with reduced maintenance costs.

References

1. Penetron, "Penetron BioMIC", Datasheet [v.H1]
2. Report of Results for modified ISO 22196 Test Methods, "Verifying the antimicrobial efficacy of Penetron BioMIC against Thiobacillus bacteria"