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How to Eliminate Concrete Corrosion in Sewers and Wastewater Treatment Plants

Microbiologically Induced Corrosion (MIC, commonly known as sulfide corrosion) is a very serious problem in sewers and wastewater treatment plants (WWTP). The service life of concrete structures suffering MIC is often less than 10 years. As an example of the scope of MIC, the US Environmental Association reported that over 2,750 km of concrete sewer systems needed replacement due to MIC in the Greater Houston Area in 1992.

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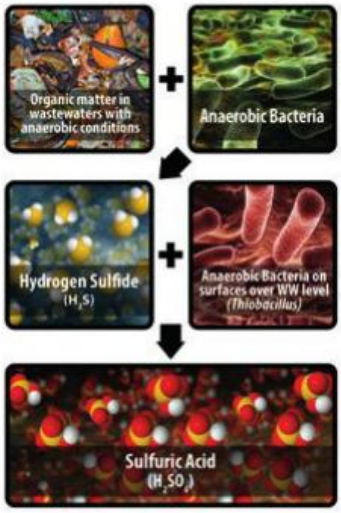
The traditional approaches that have been used to deal with MIC are the following:

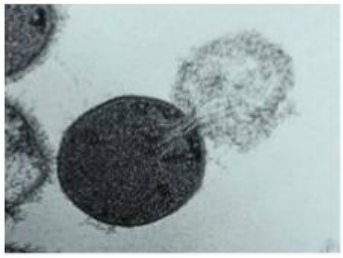
- Design and Planning measures.
- Protective measures: coatings and plastic liners.

Since 1996 an easy to use and cost-effective solution named ConMICShield® has been used in North America. Recently, it is also available in Europe and South America.

The MIC Corrosion Process consists basically in three steps:



Three Steps of MIC Corrosion Process



Bacteria wall pierced

- When oxygen concentration in the wastewater falls under 0.1 mg/l anaerobic bacteria start digesting organic matter and transform sulfur compounds into H_2S.
- H_2S is a gas, so it migrates from the wastewater into the atmosphere of sewers and WWTPs. This migration is especially intense in spots where turbulence is generated into the wastewater.
- A breed of anaerobic bacteria, called Thiobacillus, that live on the non-submerged surfaces transform H_2S into sulfuric acid (H_2SO_4) to which these surfaces are directly exposed. H_2SO_4 reacts with concrete's calcium hydroxide ($Ca(OH)2$), producing gypsum ($CaSO_4$).

Unlike any other approach, ConMicShield does not protect concrete against the corrosive action of H_2SO_4: it prevents the Thiobacillus bacteria to transform H_2S into H_2SO_4. Without H_2SO_4 concrete will not suffer MIC damage.

Design and Planning Measures

In order to minimize H_2S build-up, all the pipes should be provided, if possible, with a minimum self-cleaning slope that prevents solid deposits of organic matter and favors the air re-entrainment needed to prevent anaerobic conditions.
The use of pipes flowing full lead to anaerobic conditions and should also be avoided. Furthermore, when these pipes that are flowing full meet the sewer network, most of the H_2S generated migrates directly into the sewer atmosphere due to turbulence around the discharge spot.
It is also important to minimize, if possible, turbulence caused by changes in direction or slope, effluent jumps, etc. that release big quantities of the H_2S generated upstream. H_2S is a gas heavier than air, so most of the H_2S released due to turbulence remains in the area until it is transformed into H_2SO_4.
Regulations that minimize H_2S discharges into the sewer network coming from septic and industrial sources are also important.
If it is not possible to control H_2S build-up, chemical substances that cause H_2S to precipitate upstream of the turbulence spots can be added to the wastewater. This has to be made on a constant basis and is very expensive.

CrystalX self healing effect

Protective Measures

Epoxy or polyurethane coatings and plastic liners are inert to low H_2SO_4 concentrations found on the non-submerged walls of sewers and WWTPs. In both cases there is a limitation in service life and extra cost associated to plant and/or extra works.
ConMicShield is an innovative alternative to easily, totally, and permanently protect concrete structures against MIC. It is a water based additive, compatible with most additives, that is easily added to the concrete mix at batching time relieving additional work in the field and at the plant, saving time and money.
Once incorporated into the concrete, it bonds to it at a molecular level: it cannot leach out or dissolve, chip off, pinhole or delaminate. If the concrete's surface is damaged or eroded, the underlying concrete fortified with ConMicShield remains in place for full protection.
ConMicShield is a highly charged cationic polymer. As Thiobacillus bacteria contact treated concrete, an electric discharge pierces their cell wall, killing them by physical instead of chemical means, so they cannot develop any resistance to its action or generate any toxic metabolics. The chain of MIC process is broken: without Thiobacillus bacteria H_2S never turns into H_2SO_4 and concrete doesn't corrode by MIC.
ConMicShield, a product registered by the US Environmental Protection Agency, is safe to handle and environmentally friendly. It's not toxic for humans, animals or plants: it just makes concrete surface uninhabitable for microbes.
Many tests carried out in independent laboratories over the past 16 years, both for new and old concrete, show that 99.99 % of the Thiobacillus die after just 24 hours in contact with treated concrete.
Many field tests have also been carried out by water authorities and engineering companies, suspending treated and untreated specimens together in environments with very high H_2S emissions. Treated specimens have always remained intact. And what is even more important, over 180,000 square meters of ConMicShield treated concrete in sewers with harsh corrosive environments have shown zero failures.
ConMicShield is a very cost-effective solution. This difference is even greater due to the much superior service life that it offers.
ConMicShield has been extensively used for years in large projects in many important and demanding municipalities like Chicago, Miami, St. Louis and Milwaukee. An example is "Black Point" WWTP (Miami), a project of $3.5 billion that used more than 7,000 cubic meters of ConMicShield treated concrete.

CrystalX®

In cases where infiltration or water tightness could be a problem, ConMicShield can be used together with CrystalX, a fully compatible liquid additive that reacts, in the presence of water, with some of the products of cement hydration producing millions of micro crystals that seal the capillary pores and micro cracks of concrete but still permit gases and vapors to pass through.
Concrete treated with CrystalX remains watertight under very high head pressures (up to 140 meters water column).
Another important advantage of CrystalX is that chemical (carbonation, chlorides, sulfates...) or physical agents (freeze/thaw cycles) that attack concrete or its reinforcement by penetrating through its capillary pores or cracks are prevented from getting in.
Together, ConMicShield and CrystalX enable precast producers to make higher quality concrete pipes and manholes. ■

FURTHER INFORMATION

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