TECH TIPS FROM NASSCO

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MANHOLE REHABILITATION: IS CORROSION REALLY CAUSED BY H_2S?

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Hydrogen Sulfide (H_2S) is extremely dangerous to people, and can cause significant damage to pipes and manholes. Yet few people understand how it works in our pipelines.

Our industry often (incorrectly) refers to the deterioration of sewer pipe, manholes and lift stations as "a gas problem" when the real culprit of concrete deterioration is microbial-induced corrosion, or MIC. It is a process whereby anaerobic (non-air, or oxygen breathing) bacteria common to municipal waste flows form in raw sewage effluent and naturally create hydrogen sulfide gas (H_2S). Initial factors contributing to rapid bacterial growth are temperature, retention time, and high biochemical oxygen demand (BOD) levels. These factors are common in force mains, but can also occur in large flat pipes with little aeration of the sewage. The H_2S gas is then metabolized by aerobic bacteria which create large quantities of sulfuric acid.

When the effluent becomes turbulent, such as when a force main enters a gravity manhole, more hydrogen sulfide gas is released. The H_2S gas collects above the flow line where it combines with carbon dioxide (CO^2). Both of these "acid" gasses produce a mild, weak acid solution when they dissolve into the sewer's moist environment. These acids combine with the calcium hydroxide in the concrete to reduce the pH of the surface.

As soon as the pH of the concrete falls from its initial levels of 11-12 to around 9, biological colonization of aerobic (air breathing) Thiobacillus bacteria will begin. The countdown to serious corrosion and collapse begins at this point since bacteria have the unique ability to convert hydrogen sulfide gas into sulfuric acid (H_2SO_4) in the presence of oxygen.

Severely deteriorated, seven year old pump station discharge manhole in Central Ohio.

Same manhole after rehab with 1.5" thick cementitious liner with antibacterial additive.

Since the production of sulfuric acid from hydrogen sulfide is an aerobic-biological process, it can only occur on surfaces exposed to atmospheric oxygen. The primary product of concrete decomposition by sulfuric acid is calcium sulfate ($CaSO^4$), more commonly known by its mineral name, gypsum. Calcium sulfate is usually present in sewers and structures as a pasty white mass on concrete surfaces above the water line. Because Thiobacillus bacteria are aerobic, they require free atmospheric oxygen to survive. Therefore, they can only live on the thin outer covering of any surface. This means that acid produced on the surface must migrate through any existing gypsum paste to reach sound concrete.

One way to break this chain of events would be to eliminate the H_2S gas that is released as a result of turbulence into the airspaces of sewer structures. This is what causes the rotten egg odors sometimes associated with sewer collection and treatment processes. Since it is usually not feasible to either decrease retention time in force mains or increase the slope of large gravity lines to increase aeration of the sewage, numerous products and methods have been introduced to control the generation of anaerobic sulfide in wastewater that ultimately creates H_2S, including:

- Oxygen injection
- Chlorination
- Hydrogen peroxide
- Iron and zinc salts
- Shock dosing with sodium hydroxide
- Potassium permanganate
- Sodium nitrate
- Ozone
- Bacterial cultures and enzymes.

These methods only mask the real problem and can prove to be expensive over time. An alternative method of reducing this type of corrosion (MIC) is to permanently affect the bacterial-cell growth so the bacteria can no longer grow and therefore convert H_2S gas to Sulfuric Acid (H_2SO_4).

There are a few antibacterial admixtures available on the market that are added to the mix water of a cementitious manhole rehabilitation mortar. This combination not only rehabilitates the deteriorated structure, but also creates an unfriendly and uninhabitable environment for Thiobacillus bacteria growth, which will eliminate the formation of sulfuric acid, that we now know to be the real culprit in wastewater collection system deterioration.

These products are water soluble, cannot wash off, deteriorate, lose their effectiveness from wear and are safe for human and animal contact. Abrasion or erosion of the concrete surface only serves to expose additional material to the surface, which would otherwise foster bacterial growth. The end result is structural integrity has been restored to the deteriorated structure and its life will be extended well into the future.