Wastewater's Contribution to Concrete Corrosion

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An overwhelming amount of funding is needed in the United States to repair or replace aging concrete sewage infrastructure, and a team of scientists is trying to better understand how

certain compounds affect the structural integrity of wastewater collection systems by evaluating bacteria, gases, and other compounds that contribute to the deterioration.

Knowing the condition of the pipes can provide valuable clues that utilities can use to pinpoint which conduits may need repair before they leak or break.

The team of researchers from the University of Colorado, Boulder, Department of Civil, Environmental, and Architectural Engineering, headed by Mark T. Hernandez, found a big part of the problem lay with the sewer gases that feed acid-generating microbes that grow in colonies, forming biofilms inside the pipes. It has been well known that these microbes do play a factor in corrosion, but the specific kinds of bacteria and other conditions contributing to corrosion problems were not well known. This research sought to address those questions.

Costly Maintenance

Maintaining U.S. wastewater collection systems alone costs $4.5 billion per year, according to the researchers. The researchers cited U.S. Environmental Protection Agency estimates that more than 8,000 miles of sewers will need

rehabilitation in the next 20 years. The Congressional Budget Office estimates that the cost of restoring wastewater infrastructure could eventually exceed $12 billion.

The associated problems can surpass cost alone. As the EPA notes:

Corrosion of wastewater pipes can result in the release of untreated wastewater into the environment. Corrosion can shorten the water systems' life span and increase customer costs. Corroded water mains and sewer pipes can leak or break causing soil erosion and damage roadways.

The agency is researching various parameters that might affect the life span of systems and that can ultimately reduce the need for repair. This includes testing and developing better maintenance practices able to eliminate the need to rehabilitate systems.

Toxic Gases

As well as eroding the concrete pipes, the gases are toxic and potentially harmful to human health. Hydrogen sulfide gas, for example, can cause eye irritation as well as nervousness, dizziness, nausea, headache and drowsiness. In higher concentrations, it can kill. It does have a benefit

in that its telltale rotten-egg odor can alert building occupants to problems well before it reaches high concentrations, as ammonia can. The University of Colorado, Boulder, researchers studied the bacterial diversity, gas concentrations in the air above the wastewater and other factors in 10 sewer systems in major U.S. cities. They took 36 samples.

The Economist summarized:

One of their interests was in the mixture of bacteria found in pipes in different states of repair. Rather than culturing these, a process to which not all species are amenable, they ran them through a mass DNA screening that shows up everything in a sample. They also measured the acidity of the sewage soaked into the pipe wall near where the sample was collected and recorded the concentrations in the air there of hydrogen supplied, methane (another gas produced by bacteria) and carbon dioxide (which assists the transformation of hydrogen sulphide into sulphuric acid).

Increased Acidity

What they found is that the acidity in the most corroded pipes is on a par with battery acid. In undamaged pipes, the pH is roughly neutral.

They also found there is a mix of bacteria present, with hundreds of species present in undamaged pipes, while there were 10 or fewer species, including Aciditiobacillus, in the damaged pipes. Acidithiobacillus is dominant in the damaged pipes and is responsible for converting hydrogen sulfide into sulfuric acid. Specifically, they quantified the hydrogen sulfide levels responsible for the most damage, finding it in concentrations exceeding 100 parts per million. This confirmed long-held assumptions. They also found the carbon dioxide levels were high — greater than 1 percent by volume. In normal air, the concentration is 0.03 percent.

Finding Potential Problems

What this means is municipal systems can use conventional, affordable gas analysis technology to determine potential problems. Detecting issues before such a gaseous stew can wreak havoc can save utilities the cost of repairing broken sewer pipes by proactively preventing damage in sections of pipe at high risk for corrosion.

In an extension of their research, the team will create and test an antimicrobial coating. Some of the testing will be devoted to determining

specifically how it inhibits the growth of sulfide-oxidizing bacterial cultures.

The recent findings — “Carbon Dioxide and Hydrogen Sulfide Associations with Regional Bacterial Diversity Patterns in Microbially Induced Concrete Corrosion” — were published in the journal Environmental Science & Technology.