

Overcoming Hydrogen Sulfide

by Jeff Privott

North Carolina municipalities employ treatment technologies in sewer lines to reduce odor complaints & prevent corrosion



Wastewater treatment plant personnel can face public scrutiny over odor emissions from treatment plants and wastewater collection system networks. Hydrogen sulfide (H_2S) is the most common cause for odor complaints and is dangerous to health, and therefore utilities attempt to mitigate H_2S production with solutions such as chemical addition or carbon filters. In addition to odor, H_2S converts to sulfuric acid (H_2SO_4) in collection systems, and can cause millions of dollars of infrastructure damage due to corrosion.

The Problem With Hydrogen Sulfide

H_2S gas is extremely toxic even at low levels. In fact, the Occupational Safety & Health Administration considers concentrations of 100 ppm or greater to be "immediately dangerous to life and health," and notes the effects can be extremely rapid, even within a few breaths.

Odor from H_2S is another problem. It is detectable by the human nose at concentrations as low as 0.5 ppb, and historically has been considered the cause for most wastewater odor complaints from local residents.

Perhaps most importantly, H_2S is a corrosive gas that attacks exposed pipe and pumping station wells made of cement, and steel accessories within an enclosed wastewater collection system network. Additional corrosion occurs when H_2S converts to H_2SO_4 in networks. The corrosion rate on exposed concrete pipe and walls can be as much as 0.01 to 0.25 in. per year of lost thickness. The cost to replace or repair pipe affected by sulfuric acid corrosion can be significant. For example, the County Sanitation District of Los Angeles County estimated it would need to spend \$130 million to replace or repair approximately 25 miles of sewers that were severely corroded by H_2S and H_2SO_4 . Actual refurbishment

costs vary per site, based upon location (city or rural), pipe diameter, pipe material, soil condition, access, bypass pumping availability, depth and traffic control, among others, and requires a thorough engineering review to quantify.

Biological Sulfide Production

Bacteria commonly present in wastewater collection systems use dissolved oxygen, nitrate and sulfate as oxygen sources for respiration, in that order of preference. Dissolved oxygen is usually present in "fresh" wastewater, but is rapidly depleted by biological activity. There typically is little nitrate present in wastewater, but sulfate is usually abundant. Because little or no nitrate is available, the bacteria begin utilizing sulfate when dissolved oxygen is depleted. Sulfate (SO_4) and nutrients from the wastewater diffuse into the anaerobic slime layer on the surface of wastewater pipe, where sulfate-reducing bacteria form sulfide and alkalinity. The sulfide diffuses back into the wastewater stream, combines with hydrogen ions to form H_2S and diffuses into the headspace above the waterline as H_2S gas by turbulence in the wastewater stream. H_2S gas is oxidized to H_2SO_4 by thiobacillus bacteria living on sewer walls above the sewage. The bacteria are autotrophic, and obtain carbon from the air, not from the wastewater. The acid subsequently condenses along the pipe wall and creates significant corrosion to any concrete or ductile iron surface exposed to the air.

The H_2S and H_2SO_4 created by the processes described above cause odor and corrosion problems in wastewater collection systems.

Odor Control Issues

Two North Carolina municipalities were faced with odor complaints and were concerned about potential corrosion in their collection systems. Monitoring in the sewer lines indicated peak H_2S atmospheric concentrations of 300 to 500 ppm. Both clients desired H_2S concentrations of less than 20 mg/L to prevent future corrosion in their concrete lines, and preferred levels to be even lower to prevent odor in the local communities.

Pilot Trial Site No. 1

The client identified a pump station located in a public park generating atmospheric odors and odor complaints. The line was a 14-in.-diameter ductile iron (DI) line, approximately 6,300 ft long, with a manhole approximately 1 mile downstream from the pump station, which was emitting H_2S odors and generating complaints. Atmospheric H_2S at this location was greater than 200 ppm on average, with peaks of up to 500 ppm. At this concentration, H_2S was not only a nuisance to locals, but also dangerous to those who may enter the confined area to perform maintenance.

Pilot Trial Site No. 2

The client identified a master pump station within close proximity to a newly developed subdivision that was generating odor complaints. The line was a 16-in.-diameter ductile iron line approximately 3 miles long, equipped with air release valves (ARV) in manholes. Veolia's evaluation of the pump station showed significant odor and corrosion in the pipe and manhole areas. Atmospheric H_2S in this line was greater than 50 ppm average, with peaks greater than 300 ppm.

Solution & Results

In both locations, Veolia dosed non-hazardous Hydrex 6035 calcium nitrate at the pumping station. Nitrate addition controls dissolved sulfide through two mechanisms:

1. Sulfide prevention, where nitrate replaces sulfate as an oxygen source, and prevents sulfide production by forcing an anoxic denitrification reaction producing no sulfide, instead of the

"untreated" conditions where bacteria consume sulfate and a carbon source to produce sulfide.

2. Sulfide removal of existing sulfide in the bulk flow and upper layers of the slime layer, using naturally-occurring bacteria to biochemically oxidize dissolved sulfide in the presence of nitrate.

Calcium nitrate was able to achieve an average of less than 5 ppm and as low as 1 ppm H₂S in the collection line.

The calcium nitrate dose was based upon sewage flowrate and H₂S concentration in the lines.

In the future, pilot site no. 1 will optimize chemical dosing utilizing Veolia's patented ThioBox

technology. Results from that study will be published upon completion.

The owners of pilot site no. 2 felt that the cost of the chemical treatment alone was outside their available budget. Therefore a more economical solution was proposed to the client, which combines Hydrex 6035 calcium nitrate to reduce H₂S to less than 20 mg/L, and carbon scrubbers to polish atmospheric odor emissions from the manhole. The estimated yearly cost of this solution is lower, and includes chemical costs, carbon replacement costs, and annualized initial purchase of manhole covers and carbon vent pipe.

A combined solution of chemical and carbon from

Veolia provides an optimized, cost-effective solution to these two municipalities in North Carolina. The solution ensures future corrosion is mitigated by decreasing atmospheric H₂S concentrations in the collection system headspace to less than 20 mg/L using calcium nitrate chemicals and minimizes nuisance odors exiting the collection system by polishing with carbon scrubbers in the manhole and vent pipe. **w&w**

Jeff Privott is Hydrex product manager for Veolia's U.S. Municipal Solutions. Privott can be reached at jeff.privott@veolia.com.

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