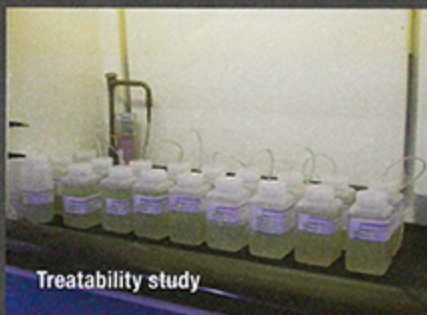


CONTROL OF HYDROGEN SULFIDE GENERATION



Treatability study



Lift station



pH control building



Treatability setup

Water and sewer authority installs pH control system in new force main

By Jim Lewis

With expectations of continued growth in southern Douglas County, Ga., the Douglasville-Douglas County Water and Sewer Authority (WSA) installed a force main from its new St. Andrews Pump Station to its existing South Central Pump station. Due to major growth in 2007, the new 16-in.-diameter, concrete-lined metal force main pipe initially was anticipated to carry 20,000 gal of wastewater per minute a total distance of 10.8 miles. Over time, this flow was expected to increase with the construction of subdivisions in the area and the tie-in of two existing schools.

Because of the initial low flow and the long distance (hence a long retention time of approximately 30 days in the pipe), the WSA was concerned about the generation of hydrogen sulfide gas in the force main and microbial-induced corrosion.

Sanitary Pipe Corrosion

Sanitary wastes contain a variety of organic and sulfur compounds. The sulfur cycle occurring within the wastewater as it flows down the sewer pipe is fairly well understood. Sulfates [SO_4^{2-}] are reduced by naturally occurring sulfur-reducing bacteria, in the absence of oxygen, to hydrogen sulfide [$\text{H}_2\text{S}_{(aq)}$]. The $\text{H}_2\text{S}_{(aq)}$ migrates as a gas [$\text{H}_2\text{S}_{(g)}$] into the air space, where it is oxidized by sulfur-oxidizing bacteria into sulfuric acid [H_2SO_4].

The sulfuric acid produced by the bacteria attacks concrete and metal pipes. Depending on individual conditions, this attack may be swift or occur over a long period of time.

Factors Influencing Sulfide Generation

The rate of sulfide generation in a sewer system depends on the following six factors:

1. Concentrations of nutrients and organic material in the sewage. The rate of sulfide generation is proportional to the biochemical oxygen demand (BOD_5) if excess sulfate is available. If excess sulfate is available, but BOD_5 is low, the rate of sulfide production will be limited due to the scarcity of organic matter.
2. Sulfate may be a limiting factor at concentrations below 20 mg/L.
3. If the dissolved oxygen concentration is higher than 1 mg/L, sulfate reduction will be eliminated.
4. The pH of the wastewater.
5. The rate of biological activity of sulfate-reducing bacteria doubles with every 10°C [50°F] increase in temperature.
6. As retention time of the sewage within the collection system increases, the oxygen consumption increases, thus favoring the activity of sulfate-reducing bacteria.

Evaluating Options

With new sewer installations, there are a variety of options available for reducing corrosion. These can include linings and anti-microbial concrete piping. With existing installations, options can be limited. Coatings and sliplining can be viable options if conditions warrant, but the traditional method is regular or continuous dosing of chemicals to break the sulfur cycle by changing one of the above-stated factors. This can be done by oxidation, reduction, pH control or precipitation.

Treatability Studies

Three separate treatability studies on the specific wastewater samples were conducted by engineering affiliate Rindt-McDuff Associates Inc.:

1. An initial sulfide stabilization and H_2S generation using various chemical additives to determine the impact of the additives on sulfide concentration (changing the aforementioned factors).
2. A second sulfide stabilization study based on the findings of the first study.
3. A treatability study of the impact of 30-day-old sewage on the downstream biological treatment processes at the publicly owned treatment works (POTW).

The treatability tests were conducted to simulate the expected 30-day retention time of the sewage in the force main. Tests were run on each of the aforementioned generation factors, and H_2S generation was measured.

Based on the results of the treatability studies, WSA decided to pursue the traditional method of pH control of hydrogen sulfide (factor No. 4) for its existing sewer system. Increasing the pH reduces the proportion of $\text{H}_2\text{S}_{(aq)}$ in the $\text{H}_2\text{S} \leftrightarrow \text{HS}^-$ equilibrium. At a pH of 7.0 SU, equal concentrations of dissolved H_2S and HS^- exist in equilibrium, while at a pH of 8.0 SU, only about 10% of the dissolved sulfide exists as $\text{H}_2\text{S}_{(aq)}$. Increasing the pH reduces corrosion by maintaining the dissolved sulfide in the HS^- or S^- form. The treatability tests determined that raising the pH to 10.0 SU at the St. Andrews Pump Station would maintain a pH range of 9.0 to 9.5 at the end of 30 days. This was found to have no adverse impact on the biological processes at a POTW.

System Design & Construction

The installation of a pH control system for this force main was the most economical and effective system to control $\text{H}_2\text{S}_{(aq)}$. For this site, the most effective location for the chemical addition was the existing debris manhole (wet well) at the St. Andrews Pump Station.

A small, heated metal building was erected at

ARTICLE SUMMARY

Challenge: Addressing sewer corrosion due to hydrogen sulfide gas generation conditions.

Solution: Installation of a pH control system delivers most economical and effective results.

Conclusion: The force main has remained corrosion-free much longer than initially anticipated.

the pump station. Inside the curbed building is a 1,550-gal double-walled polypropylene containing sodium hydroxide (caustic soda). A heated building was necessary due to the freezing point of 50% caustic soda. Dosing lines in secondary containment run from the building to the debris manhole.

Existing pumps in this wet well provided the mixing. Because characteristics of domestic sewage at the lift station are fairly constant, dosing is based on water level inside the wet well—which was fitted with an ultrasonic level transmitter—rather than pH. When the transfer pumps are running, caustic soda is dosed at the previous rise rate. When pumps are off, dosing is based on the rise rate of the water.

Ongoing Operation

When this project began, flow was expected to increase in subsequent years; thus, the installation of a pH control system would be temporary. Due to the current economic conditions, however, growth in this part of Douglas County has fallen short of plan.

So it follows that this seemingly temporary pH control system has been in operation longer than initially anticipated, and it continues to perform as designed. The Douglasville-Douglas County WSA has seen no corrosion in the force main and no adverse impacts on the POTW from the long-retained sewage.

Author's note: I would like to thank Keith Higgs of the Douglasville-Douglas County Water and Sewer Authority, Robert E. Hadden of Rindt-McDuff Associates Inc., and Karen J. Niebuhr, P.E., of Complete Water Services LLC for their assistance with this article. [www](#)

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For more information, write in 1109 on this issue's reader service form on page 38.

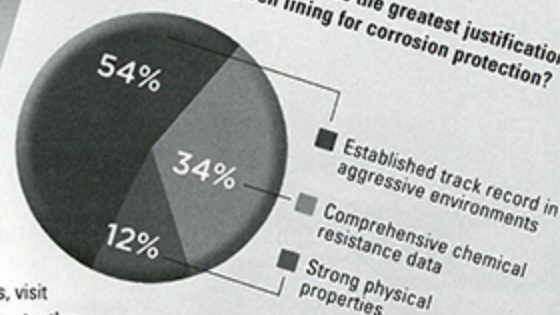
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