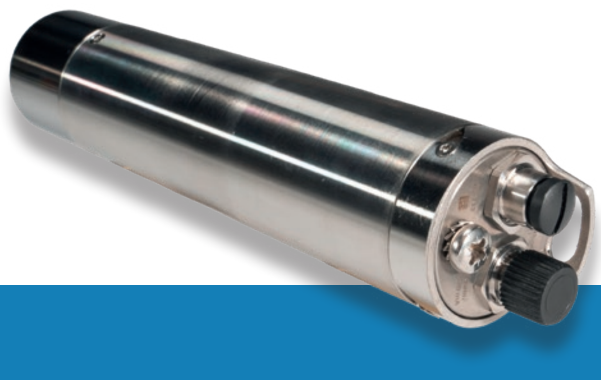
Take Control of Problem Odours and Corrosion with H_2S Monitoring

Discover how the Central Valley Water Reclamation Facility achieved over $120,000 in annual savings.



Application Note

Revolutionising Odour and Corrosion Control with Realtime H_2S Monitoring at the Central Valley Water Reclamation Facility

From Odours to Corrosion

When nasty odours formed in the sewers find their way to a neighborhood BBQ, calls are made, actions are taken, and the odour issue is quickly addressed. Unfortunately for one of the city's most important assets, it's already too late.

The sewer collections system is one of the largest assets a city owns and it's out of sight and out of mind for most, which can lead to less attention and upkeep for years or even decades. That asset conveys wastewater from every corner of the city to the water reclamation facility.

The collections system represents a giant physical network including piping made from materials like concrete, brick, and steel. Lift stations are spread throughout the system including pumps, sensors and electrical equipment and can vary in size from simple small pumping systems to deep structures designed for temporary occupancy.

If odours have made it out of the collections systems and found their way to a summer BBQ, that means hydrogen sulfide (H_2S) has likely already done its work degrading and corroding infrastructure. The US Environmental Protection Agency has estimated that this problem alone has caused billions of dollars of damage to US infrastructure.[1] The trick to solving this problem is to figure out how to stop the issue at the source to protect these important and expensive assets. This was not possible to do in the past, but a new technology is revolutionising H_2S management enabling cities and treatment works to save big on chemical costs and protect infrastructure.

An example will be discussed in this application note where the Central Valley Water Reclamation Facility in Utah had successes optimising treatment leading to a savings of over $120,000 in the first year. Many aspects of Hydrogen Sulfide including corrosion, odours, monitoring, and mitigation strategies will be covered in this impressive story of leveraging new technology.

Background: Hydrogen Sulfide (H_2S)

The Relationship Between Dissolved Sulfide and Hydrogen Sulfide

Hydrogen Sulfide falls within the classification of dissolved sulfides. Dissolved sulfide can form within a sewer system or tank where anaerobic conditions occur. Dissolved sulfides form in a few ways in these conditions.

- In slow moving gravity systems, stagnant tanks, and anaerobic conditions, warm wastewater begins fermenting with bacteria that convert suspended and soluble organic matter into volatile acids such as acetic acid as well as carbon dioxide, hydrogen, and hydrogen sulfide.
- Sulfate can also be converted into dissolved sulfide by anaerobic biofilms of sulfate reducing bacteria. Areas where seawater infiltrates sewer systems can have particularly high levels of sulfate and correspondingly, high levels of dissolved sulfide.
- Dissolved Sulfide may also enter the sewer collection system directly from industrial sources.

When looking at the forms of sulfide and understanding hydrogen sulfide production, there is an important distinction and common point of confusion:

Dissolved Sulfide is not the same as ***Hydrogen Sulfide***

[1] United States Environmental Protection Agency (1991). "Hydrogen Sulfide Corrosion: Its Consequences, Detection and Control"

Dissolved sulfide has three main subspecies, one of which is hydrogen sulfide (H_2S). The remaining two species are bisulfide (HS^-) and sulfide (S^{-2}). The prevalent species between these three is pH dependent. Furthering the discussion around dissolved sulfide speciation, Table 1 helps explain the speciation as a function of pH. For example, at a pH of 4 SU all the dissolved sulfides will be hydrogen sulfide (H_2S). At a pH of 10 SU all the dissolved sulfides will be bisulfide (HS^-). And finally at a pH of 14 SU nearly all the dissolved sulfides will present as sulfide (S^{-2}).

Here are a few important notes on the pH dependency of these dissolved sulfide species:

1. The pH in many wastewater collection systems is between 5 and 9 SU. This means that the dissolved sulfide present will predominantly be a mix of hydrogen sulfide and bisulfide.
2. If the pH increases or decreases after a sampling point, the fraction of hydrogen sulfide to bisulfide will change. As an example, at a pH of 7 SU around 50 percent of the dissolved sulfide is H_2S, and 50 percent is HS^-. If the pH drops later in the system, there will be a corresponding increase in H_2S.

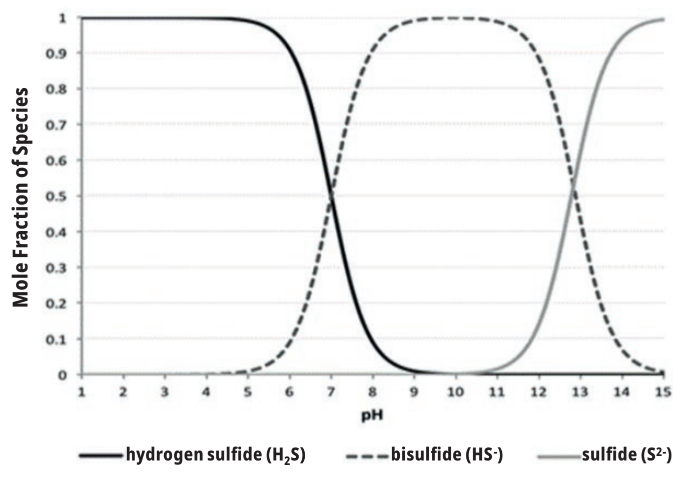


Table 1

Hot spots (from liquid to gas)

If H_2S can be mitigated in the liquid phase and can be kept from entering the vapour/air phase it will effectively reduce corrosion and destruction of the collections system, lift stations, and headworks facilities. If H_2S can be managed outside the fence of a water reclamation facility at the various sources, it may reduce odour issues inside the fence. Less H_2S present inside the fence at a facility headworks can reduce the size of or cost of odour control systems. Less H_2S entering a facility also provides a safer work environment for plant staff.

For decades odour control started and finished by monitoring the vapor/air phase. There are measurement and logging products that are widely used for this purpose. The challenge to overcome is that by the time H_2S has entered the air, corrosion is already beginning. Though monitoring hydrogen sulfide in the vapour phase can be a useful tool for areas where hydrogen sulfide is present and already causing damage, there are additional challenges with traditional vapor phase monitoring technology which have been reduced or eliminated with the new technology discussed here. The best mitigation strategies deal with hydrogen sulfide in the liquid phase by either preventing the formation of hydrogen sulfide or mitigating it as it is formed.

Both strategies have one key strength in common – keeping hydrogen sulfide from transferring from the liquid to the vapour/air phase.

Stopping the destruction of indispensable assets to keep our communities, cities and environment safe starts here.

Testing the liquid for dissolved sulfide using grab sample testing has become more common in wastewater collection and treatment systems. This can give insight into the possible H_2S fraction in the liquid at a given location when pH is also measured. A frustrating and ultimately destructive characteristic of hydrogen sulfide is its propensity to move from the liquid phase to the vapour/air phase with little effort. This creates several challenges for accurate sampling and understanding liquid to vapour transfer ratios. When pulling a liquid sample from any basin or piping system for laboratory analysis, liquid H_2S present will be reduced since some H_2S will be transferred to the vapour phase by the sampling process, leaving a less representative sample.

Hydrogen sulfide, being heavier than air, will sit in higher concentrations just above the water surface. Commonly used odour logging technology and application of the technology lends itself to less actionable variable data, and more importantly unrepresentative data due to a number of factors:

1. Logging devices are normally placed well above the water level, just under manhole lids, for two main reasons:
   a. Easy access for maintenance removal as often as weekly due to the moist environment.
   b. Easy access for data acquisition
2. Logging devices that are placed high up near a manhole for the necessary reasons listed above only read a fraction of vapour phase H_2S that is present.
3. Surface weather conditions above the manhole can change airflow at the device producing variable unactionable data.
4. Odour logging device technology cannot be placed just above the liquid surface due to increased moisture levels and the possibility of changing water levels submerging and destroying the device. This poses a critical problem because the most representative vapour phase hydrogen sulfide measurement point is just above the liquid level.

To better understand wastewater systems and areas where new monitoring and control strategies could help, areas within a system where H_2S is either forming or being agitated out of suspension into the vapour phase are:

- Pressurised sewer lines (force mains) where H_2S is released at the end of the pipe discharging to a manhole.
- Slow gravity sewer lines where H_2S slowly releases along the way.
- Sewer systems in newer development areas where piping is large, flows are still small, and H_2S forms under stagnant conditions.
- Stagnant periods in lift station wet wells where H_2S is formed and then released when pumping and agitation starts.
- Off season sewer systems like universities and tourist areas.
- Where H_2S is released as wastewater cascades over gates, weirs or stop logs.
- Under any anaerobic condition where H_2S formation is enhanced by higher temperature.

Central Valley Case study (The Problem):

The Central Valley Water Reclamation Facility has been managing odours and corrosion with odour logging technology and other available resources. Even with a collections system management plan in place this system had a significant pipeline fail due to hydrogen sulfide corrosion.

The system's corrosion issues were revealed in a surprising event where a large sewer siphon line collapsed opening a sinkhole approximately 6 metres in diameter that swallowed a tree. See images one and two.

Image 1

Image 2

In Images 3 through 5 the ductile iron sewer line is shown with some areas of significant corrosion and full failure. The challenge with some piping systems is that there is no back up pipe and no way to stop flow. These important systems sometimes don't have redundancy due to growth or resource allocation. In this case, the facility did have a second siphon line that was able to be used while the damaged pipe was replaced. However, in many cases, expensive above ground bypass pumping is necessary while repairs are made. Inspecting full flow pipes like siphons and force mains can be impossible or very challenging at the least. Having a good corrosion mitigation plan and utilising the best available technology is paramount.

Image 3

Image 4

Image 5

The Solution

The facility has been adding ferric compounds to their system for many years now to minimise corrosion and odours. This chemical mitigation strategy is combined with their cleaning and maintenance programs to keep the system running properly. Chemical usage is one of the facility's largest operating costs, so as an innovative treatment works, they sought out ways to optimise their chemical dosing system. At the same time with this pipe failure costing the facility $2 million in emergency repairs the utility wanted to be confident they are adding the appropriate amount of ferric chemical to keep disasters like this from happening.

Monitoring hydrogen sulfide, in real time, in the liquid phase and/or the vapour phase right above the water is an important recent technological advance in wastewater treatment. Hach®'s new sensor, the GS2440EX, measures hydrogen sulfide in the liquid or vapour phase. The harsh, humid and corrosive wastewater treatment and collections system environment present no issue for this sensor. Its rugged, compact, and tailored design allows for real-time monitoring in many wastewater applications from liquid phase to vapour/air phase. In this case study below, the wastewater facility deployed the new Hach sensor in the vapour phase. This unique tool enabled them an

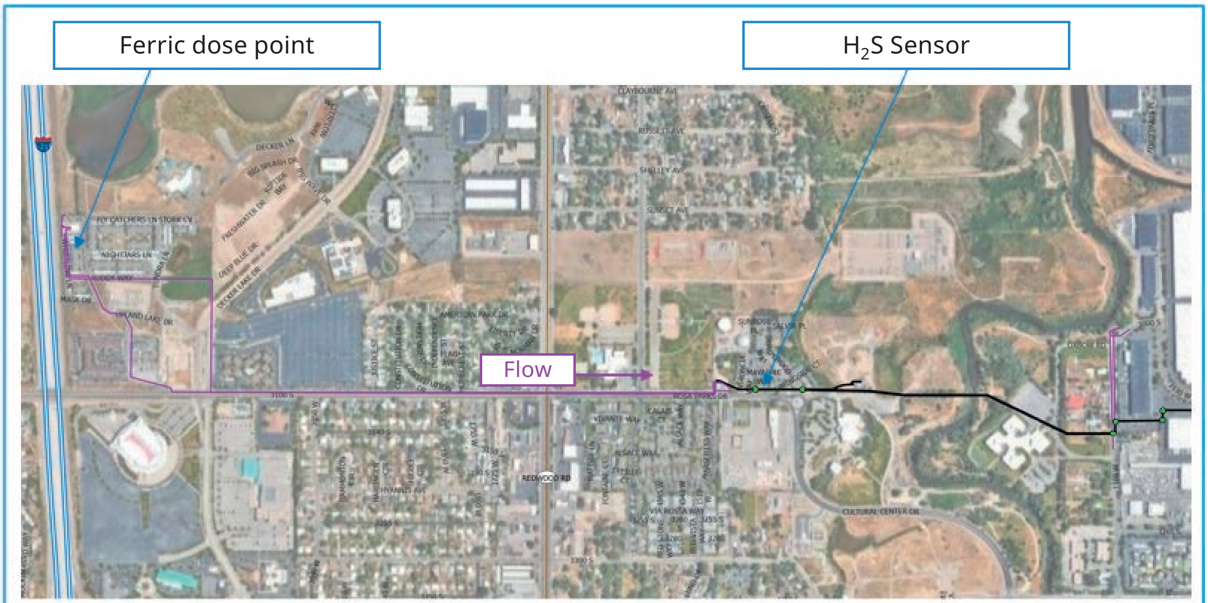


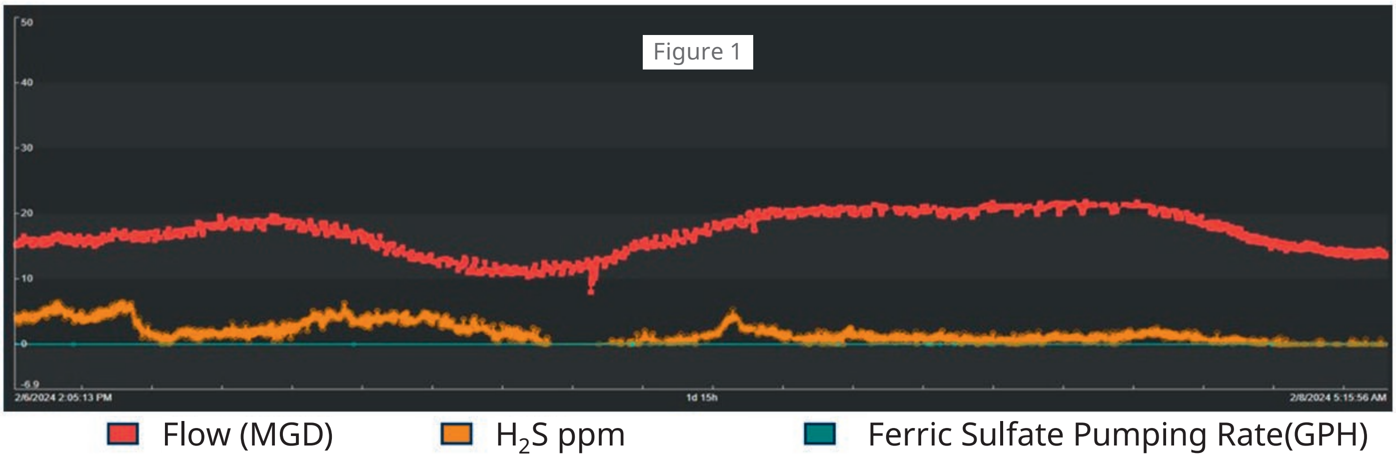
Image 6

unprecedented, real-time control point to automatically adjust their ferric dosing system.

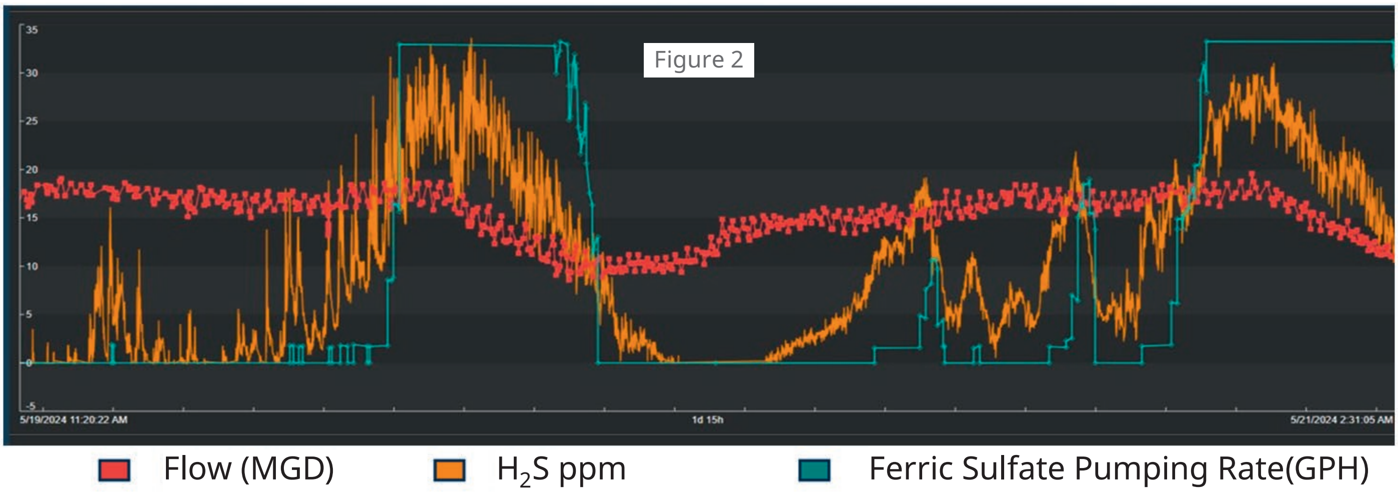
The facility decided to implement this new strategy to ensure proper chemical dosing is being utilised. Underdosing chemical treatment can result in odours and continued corrosion. Overdosing can cause issues at the wastewater facility and unnecessary chemical waste and cost. In wastewater systems the GS2440EX sensor can be used fully submerged as an approved application for measuring liquid H_2S or pulled out of the water and hung just above the surface for vapour phase monitoring, one sensor, two unique abilities. The staff knowing the sensor has no problem with moist environments installed the sensor just above the wastewater surface.

Image 6 shows the layout of their Ferric dose system utilising real-time feedback control. Ferric is dosed upstream at the Granger Hunter ferric injection site and is controlled downstream by the new Hach GS2440EX at the Granger Hunter flow station.

In Figure 1 below, after the Hach GS2440 Ex sensor was first installed in winter in the collections system, the weather was cold and therefore hydrogen sulfide was lower. To the facilities surprise they found that no chemical dose was needed during these winter months. This new reality is now about showing incredible savings and system optimisation in contrast to the previous operation. In the past, staff had to manually adjust chemical dose with regular hands-on monitoring.



In Figure 2 below, the stark change of bacterial hydrogen sulfide formation becomes evident when the weather warms in the spring. The ferric dosing system can be seen ramping up based on setpoints corresponding to an increase in the vapour phase H_2S in real time. The resulting response of a rapid decrease in H_2S levels can be seen.



Sensor Maintenance:

The GS2440EX has been installed at this site for eight months and the staff have not had any sensor degrading fouling, despite its close proximity to wastewater in an enclosed vault. The staff calibrated the sensor on install and have done calibration checks throughout the year. The recommended calibration frequency varies on the application but in general every 1-3 months is appropriate.

The accuracy of the GS2440EX sensor has been reported as always right on after calibration despite months of operation in the humid and corrosive collection system atmosphere. It is common for gas-phase H_2S logger devices to need to be removed from service and swapped as often as weekly in these conditions. The new Hach technology has proved to not need this type of attention.

Conclusion

In conclusion, this treatment system successfully improved the facility's chemical dosing using the Hach GS2440EX H_2S sensor in the vapour phase at an application point not previously feasible with older technologies. The accuracy of the sensor and low hands-on maintenance has provided the confidence needed to automate their chemical mitigation strategy.

Before the facility had the Hach solution they were spending $500,000 per year in ferric sulfate for odour and corrosion control. In the past, they were going into the field and taking regular H_2S measurements to adjust dosing. The new system has shown just how seasonally and daily variable the H_2S concentration is. Now with the ability to see in real time the actual, current values they can adjust dosing automatically or stop adding chemical with actionable data. As of today, they are 75 percent through the year and have only spent 41 percent of their ferric budget which is expected to be an annualised savings of $120,000/year.

In a quote from one of the Central Valley system managers "Having real-time data has helped us to make informed decisions, protecting our assets and saving the facility money." Hach's GS2440EX sensor brought a level of visibility not previously possible in water and wastewater treatment. Vapour phase monitoring coupled with the Hach SC4500 controller using 4-20mA chemical control has exceeded staff expectations.

Hach's new sensor and its unique amphibious ability to be placed in the proper application point just above the liquid surface or fully submerged has shown this technology to be the best in class for protecting indispensable wastewater infrastructure. The staff has seen excellent consistency monitoring H_2S in the vapour phase near the water surface compared to previous monitoring technology application points. The importance of a stable, consistent data stream without the strong influence of air flow conditions near a hatch or manhole lid has proved to be indispensable using this new technology."

Are you looking to revolutionise your odour and corrosion control strategy?

We invite you to request a customised quote tailored to your specific needs.

With the GS2440EX sensor, you'll get instant insights into H_2S levels in both liquid and vapour phases, allowing you to optimise chemical dosing and reduce operational costs.