CONTROLLING ODOUR AND CORROSION IN SEWER SYSTEMS USING SULFALOCK™ MAGNESIUM HYDROXIDE LIQUID

Brian Parsons
Maroochy Water Services
tradewaste@maroochy.qld.gov.au

Anton Silove,
Robert Van Merkestein
Orica Watercare
anton.silove@orica.com
robert.van.merkestein@orica.com

Abstract

Hydrogen sulphide odour emissions from sewage treatment plants, rising mains and pump stations are of concern to municipal authorities.

Magnesium hydroxide liquid is a safe and gentle alkali reagent that is widely used for acid neutralisation. It can also be applied very effectively to control odour and corrosion problems in sewage networks. The use of magnesium hydroxide liquid for odour and corrosion control is a well established technology in the US and is rapidly gaining acceptance in Australia.

Dosed directly into sewers or pump stations, magnesium hydroxide liquid (marketed in Australia under the trade name MHL and SulfaLock™) controls odours by preventing the evolution of hydrogen sulphide gas ($H_2S_{(g)}$) from sewage.

The use of SulfaLock™ is particularly well suited to sewer systems characterised by high biological oxygen demand (BOD) and sulfide levels and those which suffer from depressed wastewater pH, ie systems that require some form of pH adjustment anyway.

This paper presents a case study detailing the application of SulfaLock™ for odour and corrosion control in a sewage reticulation system and wastewater treatment plant.

1. INTRODUCTION

Odour emissions from manholes, sewage pump stations and treatment plants is a problem faced by an increasing number of Water Authorities throughout Australia. Not only are odour complaints an issue, the fact that odours are experienced can indicate that corrosion within the reticulation system may also be occurring (Ochre & Van Merkestein, 2002).

Dosed directly into sewage, SulfaLock™ has been shown to constitute an effective and environmentally friendly treatment to control the hydrogen sulphide (H_2S) odour problem associated with many sewer networks.

The performance of SulfaLock™ for odour and corrosion control has been established in numerous field trials. These evaluation have demonstrated that SulfaLock™ can reduce H_2S gas concentrations within sewer systems by over 95%. Importantly, when the treated wastewater enters turbulent areas such as the inlet of a wastewater treatment plant, or is diluted by untreated flows, H_2S gas release is not experienced (Sickerdick *et* al, 2003).

1.1. ODOUR AND CONTROL OPTIONS

The rotten egg odour associated with sewage collection systems indicates the presence of hydrogen sulphide gas ($H_2S_{(g)}$). The fundamental objective of all odour control strategies is to reduce the amount of $H_2S_{(g)}$ emanating from manholes, pumping stations and waste treatment plant to below the limits of olfactory perception.

A number of different methods can be used to reduce the release of $H_2S_{(g)}$ in sewage reticulation systems. Specific methods include shock dosing with high strength alkali (NaOH) to kill micro-organisms; iron salt addition to precipitate the sulphide from the wastewater; oxidation of sulphides with chlorine, hydrogen peroxide, or oxygen; nitrate addition intended to promote biological nitrate reduction over sulphate reduction; or combinations of these techniques.

Although each of these technologies has been demonstrated to reduce odour (Ochre & Van Merkestein, 2002), a new chemical dosing technology, based on magnesium hydroxide offers many advantages over traditional technologies.

1.2. SulfaLock™

Magnesium hydroxide ($Mg(OH)_2$) is a slow reacting, weak base. At 60 % w/w $Mg(OH)_2$, it is also the active ingredient in SulfaLock™, a classified non-hazardous and non-dangerous liquid alkali reagent. The product is manufactured by Orica Watercare using technology developed by the CSIRO. Its unique physical properties, that is low viscosity, high concentration and stability to settling, allow SulfaLock™ to be stored and dosed as a liquid thereby eliminating solids handling issues. These properties, and the low freezing point (0°C), contribute to ease of handling.

1.2.1. Odour Control Mechanism

Sewage pH can have a profound impact on $H_2S_{(g)}$ concentrations within sewage collection systems. Increased sewage pH increases the solubility of $H_2S_{(g)}$ via a chemical change from molecular H_2S to the bi-sulphide ion (HS^-).

At near neutral pH, relatively small adjustments in pH results in large changes in H_2S dissociated in solution. The effect of pH on hydrogen sulphide speciation is shown in Equation 1 and Figure 1.

$$\underset{\text{lower pH}}{H_2S} \Leftrightarrow \underset{\text{higher pH}}{H^+ + HS^-} \qquad -(1)$$

The proportions of H_2S and HS^- species are dependant on sewage pH. The concentration of $H_2S_{(g)}$ and the soluble sulphide species in solution, at a total sulphide concentration of 5 mg/L and a temperature of 25°C, are plotted as a function of pH in the figure below.

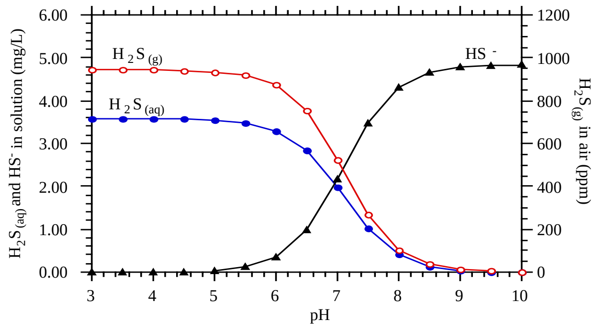

Figure 1. The relationship between Hydrogen Sulphide speciation and pH

At a pH of 7.0, approximately 50% of the total sulphide concentration is present as dissolved $H_2S_{(g)}$ and the other 50% present as bi-sulphide ($HS^-_{(aq)}$).

As sewage pH rises slightly, equilibrium shifts rapidly to the right, increasing the solubility of hydrogen sulphide until at pH 8.5, approximately 95 % of all sulphides are stable solution species.

The significantly higher solubility of HS^- results in significantly reduced $H_2S_{(g)}$ concentrations and therefore significantly reduced odour and asset corrosion.

It is important to note that SulfaLock™ does not react with dissolved sulphides present in the sewage. It works by keeping the sulphides in solution so they can't be released as $H_2S_{(g)}$. As a result, the SulfaLock™ dose is typically dependant on wastewater pH and volume. Dosing is independent of the aqueous sulphide concentration. Typically, the higher the aqueous sulphide level, the more cost effective SulfaLock™ becomes relative to traditional chemical treatment where dose rates are proportional to aqueous sulphide levels.

As stated previously, pH adjustment of waste water to pH 8.5 can correspond to a 95% reduction in odour. In theory, any alkali can be added to sewage to achieve this. However in a sewer system, highly soluble alkali's can be consumed quickly and therefore may not sustain the elevated pH for very long. This can be particularly apparent where treated sewage is subject to re-acidification as a result of high retention times, high BOD content or simply dilution with untreated and lower pH flows within the network. In practice, using a highly soluble alkali to achieve a pH of around 8.5 at some distance along a rising main requires an initial pH adjustment to well in excess of pH 8.5.

A useful chemical property of magnesium hydroxide is the inability to increase pH in excess of pH 9 - 9.5, no matter how much of the material is added. This self buffering feature allows the system to be loaded with residual or un-reacted alkalinity. This residual component is available in the event that re-acidification occurs.

This makes SulfaLock™ ideal for use in both domestic and industrial areas where sewer systems receive high BOD loadings and in those systems with long retention times. It can also allow long reaches of sewer to be treated using a single dose point. This can be important in systems where only a single dose point is possible, for reasons such as limited access to the sewer or aesthetics. Further, minimising dose points can avoid the costs associated with the construction, maintenance and operation of numerous odour control installations.

1.2.2. SulfaLock™ at the Waste Treatment Plant and Beyond

In addition to odour control in sewer networks, the increased alkalinity of sewage treated with SulfaLock™ can be of benefit at the waste treatment plant. Higher pH wastewater can reduce or eliminate both odour and the alkali addition at the wastewater treatment plant. Thus SulfaLock™ addition can achieve dual objectives; odour control and also alkalinity required to maintain the near neutral pH most suitable for aerobic and anaerobic systems. Further, as a magnesium based alkali, SulfaLock™ introduces the relatively benign magnesium ion and therefore will not contribute sodium to the wastewater. This can be important where treated wastewater is directly re-used for irrigation or discharged to water bodies which are subsequently used for irrigation (Van Merkestein & Jarvis, 2000).

2. FIELD TRIAL RESULTS

<u>MAROOCHY SHIRE COUNCIL</u>

Maroochy Shire, a regional centre located on the Sunshine Coast in SE Queensland, is investigating the potential to streamline the reticulation and treatment system. A major part of this will be the de-commissioning of the Yandina sewage treatment plant (STP) and the diversion of flow to the larger Nambour STP.

The Yandina STP currently receives relatively small municipal wastewater flows (0.35 ML/day) and low pH, high sulphate trade waste discharged by a local food processing plant (0.25 ML/day). The treated wastewater is then conveyed through a sewer consisting of two wet well pump stations, 6.6 kilometres of rising main and 2.5 kilometres of gravity sewer to the Nambour plant for further advanced treatment.

However the closure of the Yandina plant and discharge of raw sewage through the main are anticipated to create ideal conditions for hydrogen sulphide generation. Unacceptable gas levels were observed during recent trials in which untreated wastewater was diverted from the Yandina plant directly to the Nambour WTP. Therefore it is acknowledged that closure of the Yandina plant and subsequent diversion of combined municipal wastewater and industrial trade waste would require some form of hydrogen sulphide (odour) control.

An initial odour control evaluation was conducted using calcium nitrate. In the opinion of the Council, these trials were inconclusive and alternative technologies were sought. SulfaLock™ was identified as an alternative and an evaluation was performed.

A dosing system, consisting of a 1000 litre storage container with a pump and control panel was installed at a pump station at the Yandina STP. SulfaLock™ was dosed directly to the receiving manhole prior to a wet well pump station located at the Yandina treatment plant. In order to simulate conditions expected upon the closure of the Yandina plant, dosing was confined to periods in which the Yandina plant was bypassed.

The evaluation of SulfaLock™ was conducted in two stages in which hydrogen sulphide gas suppression and dose rate were established for:

- diverted flow consisting of both municipal and industrial trade waste discharged from the food processing factory.
- diverted municipal wastewater only.

SulfaLock™ dosing throughout the evaluation was performed on a continuous basis, that is the dosing pump was set a rate to deliver a certain volume per hour. However the effect of various pump dosing rates on odour suppression was evaluated.

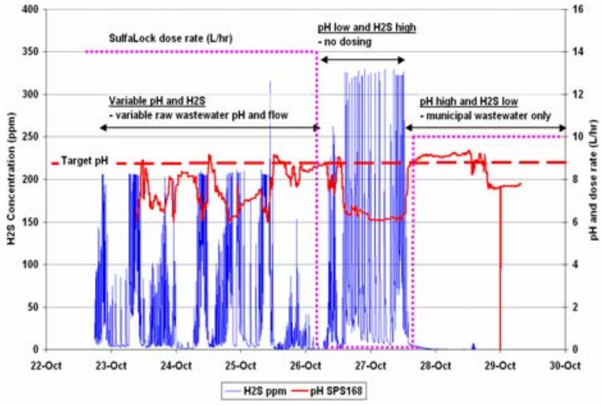

Figure 2. The effect of SulfaLock, dosed into combined municipal and trade waste and municipal only, on wastewater pH and $H_2S_{(g)}$ levels.

As shown in Figure 2, pH minimum and maximum values between pH 6 and 9 and were recorded in the period of the 23rd to the 26th October. During this period, minimum and maximum H_2S gas concentrations were observed to vary considerably between 1 and 200 ppm. The highly variable pH and H_2S gas levels observed is believed to be the result of constant rate SulfaLock dosing (14 L/hr) into a system in which a large degree of variation in both wastewater flow and pH was apparent. The result suggests that a SulfaLock™ dose rate of 14 L/hr was insufficient for a significant proportion of the period evaluated. However during those periods in which wastewater pH was maintained at or above pH 8, ie. when sufficient chemical was dosed, H_2S gas peaks were limited to 10 ppm and below constituting a reduction in H_2S levels of some 97 %.

During the period 26th to the 28th October, dosing was suspended resulting in a far more stable pH around 6 to 6.2 and H_2S gas peaks consistently above 300 ppm. The resumption of SulfaLock™ dosing at a reduced rate of 10 L/hr coincided with the elimination of the higher strength trade waste from the system. This enabled wastewater pH to be maintained at or above the target level of pH 8.5 resulting in a reduction in H_2S gas levels to an average of <1 ppm and limiting peaks concentrations to less than 10 ppm.

These results demonstrate that during those periods in which pH was maintained at or above pH 8, H_2S gas odours were effectively eliminated.

During the initial stages of the trial, significant variation in both pH and wastewater flows were observed indicating that a control system consisting of pH and flow paced control might provide more consistent odour suppression and the most efficient use of chemical. SulfaLock™ dosing strategies that are tuned to variation in pH and flow have been used successfully (Sickerdick *et* al, 2003).

The implementation of a tuned dosing regime allowing the optimisation of dosing was never implemented as the Council was satisfied with the result. Despite the variability of the results obtained, H_2S gas peaks during this period were reduced by at least 30%.

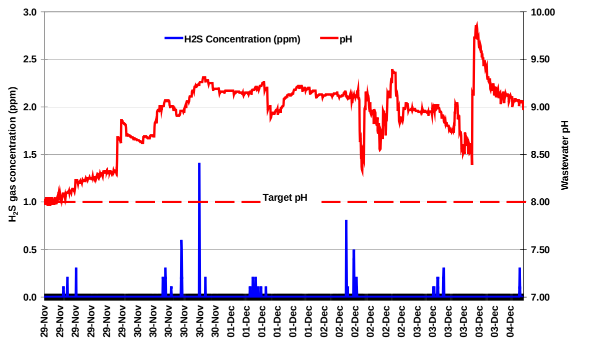

Figure 3. The effect of SulfaLock™, dosed at 5 L/hr to municipal flow only, on wastewater pH and $H_2S_{(g)}$ levels.

Figure 3 demonstrates that the addition of SulfaLock™ at a dose rate of 5 L/hr to diverted municipal wastewater only was sufficient to maintain average H_2S gas levels at or below 1.4 ppm and wastewater pH above pH 8 at all times.

There appears to be significant room for reducing the dose rate further and, with flow paced or diurnal flow pattern control, further reductions in dose rates could be achieved.

Overall SulfaLock™ dosed directly into the pump station significantly reduced H_2S levels at the subsequent pump stations. Further, it was demonstrated that when the pH increased to desired levels the hydrogen sulphide remained in solution. No odours resulted at the Nambour STP which is significant in that the treated wastewater is subject to a dilution of approximately 85% at the STP inlet works. This result indicates that a release of H_2S gas does not occur despite a significant dilution and a corresponding reduction in wastewater pH.

3. CONCLUSIONS

The case study presented demonstrates that SulfaLock™ is an effective technology for odour control within sewer networks.

SulfaLock™ is completely safe and environmentally friendly. Dosing sewage with SulfaLock™ to increase the pH of the wastewater to between pH 8 – 9, ensures that sulphides remain dissolved within the wastewater, unable to be released as a gas. In this way, SulfaLock™ can be applied for very effective odour control and to inhibit concrete corrosion.

4. REFERENCES

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