OPTIMISATION OF MAGNESIUM HYDROXIDE DOSING FACILITIES

Paper Presented by:

Keith McCarthy

Author:

Keith McCarthy, *Sewer Optimisation Technician,*

Yarra Valley Water

79th Annual WIOA Victorian Water Industry Operations Conference and Exhibition
Bendigo Exhibition Centre
31 August to 1 September, 2016

OPTIMISATION OF MAGNESIUM HYDROXIDE DOSING FACILITIES

Keith McCarthy, *Sewer Optimisation Technician*, Yarra Valley Water

ABSTRACT

There are currently six Chemical Dosing Facilities in operation across Yarra Valley Water's sewerage network. These facilities all use the chemical Magnesium Hydroxide Liquid (MHL), and dose the chemical with the objective of reducing odour and minimising the extent of corrosion at points throughout the sewerage network.

In 2014/15, Yarra Valley Water spent nearly $180,000 in purchasing the chemical. Due to the significant chemical cost, Yarra Valley Water's Sewer Optimisation Team was tasked with investigating more efficient dosing philosophies for its dosing facilities.

This paper describes the findings from Yarra Valley Water's investigations into the dosing philosophies, including:

- How a saving of $80,000 was achieved during 2015/16, despite the addition of two new dosing sites to the network. This included a saving of $20,000 per year in chemicals from one facility alone.
- What monitoring equipment was required to be installed downstream of the dosing facilities to implement the new dosing philosophy.
- What modifications were required to the existing dosing facilities.
- How the more efficient dosing philosophy was developed and refined.

The new chemical dosing philosophy was found to be a success. It is currently being replicated across the remainder of the chemical dosing facilities in Yarra Valley Water's sewerage network.

1.0 INTRODUCTION

Yarra Valley Water (YVW) uses the chemical Magnesium Hydroxide Liquid (MHL) to lift the pH**.** level of sewage at key locations within its sewerage network. This serves to keep Hydrogen Sulphide (H_2S) in its liquid phase, which increases asset life and decreases the likelihood of odour complaints.

As effective as MHL is at raising pH and lowering H_2S levels in sewerage systems, it is also a costly chemical. During the financial year of 2014/15, YVW spent close to $180,000 on purchasing MHL for its four MHL dosing facilities.

The Sewer Optimisation Team was tasked with lowering this operational cost, without impacting customers downstream of the chemical dosing facilities.

The Study Area used for this investigation was a Chemical Dosing Facility located in YVW's Brushy Creek sewerage catchment. This facility doses MHL into the sewage flow stream at a manhole upstream of a Sewage Pumping Station (SPS) and was originally configured to run on a volume-based system of 100ml of MHL for every 1kL of sewage transferred by the SPS.

2.0 DISCUSSION

2.1 Limitations of previous chemical dosing regimes

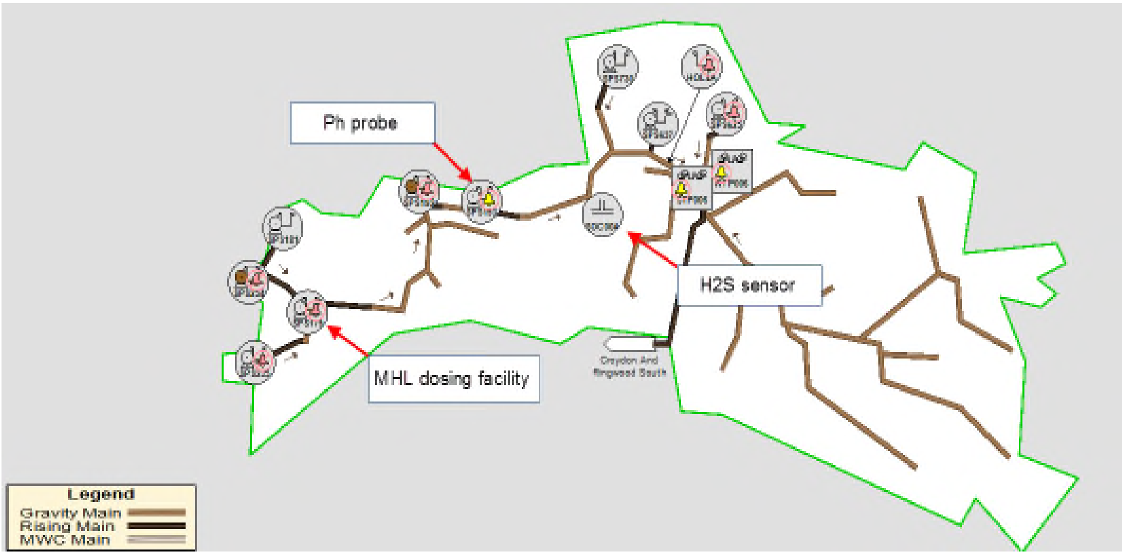
Before a new chemical dosing regime could be developed, it was important to address the key limitations of the previous methodology. These were:

1. The previous dosing regimes were volume-based, as the Chemical Dosing Facilities did not allow an adjustable dosing rate for the chemical.
2. There was no monitoring equipment in downstream sections of the network, and the success was measured by whether or not customers complained.

Therefore there was no reliable method of measuring system performance, and there was no simple method for adjusting the dosing rates.

2.2 Hardware and software modifications

As a first step, H_2S sensors and pH probes were installed downstream of the dosing facility at strategic locations. These sensors and probes allowed YVW to monitor the effectiveness of any changes that were made to the dosing regime at the MHL dosing facility.



<u>Figure 1</u>: ***Layout of YVW's Brushy Creek sewerage catchment***

As a second step, YVW installed Variable Speed Drive (VSD) starters on the chemical dosing pumps at the facility. This allowed for the speed of the dosing pumps to be altered easily, allowing for the chemical dosing rate to be adjusted in response to the H_2S and pH levels that were recorded by the downstream monitoring equipment.

As a final step, YVW's SCADA Team provided remote access to the speed set points on the VSDs of the chemical dosing pumps. This enabled the Sewer Optimisation Team to finely tune the speed of the dosing pump from the office, in response to the levels of H_2S and pH observed downstream. This can be seen in Figure 2.

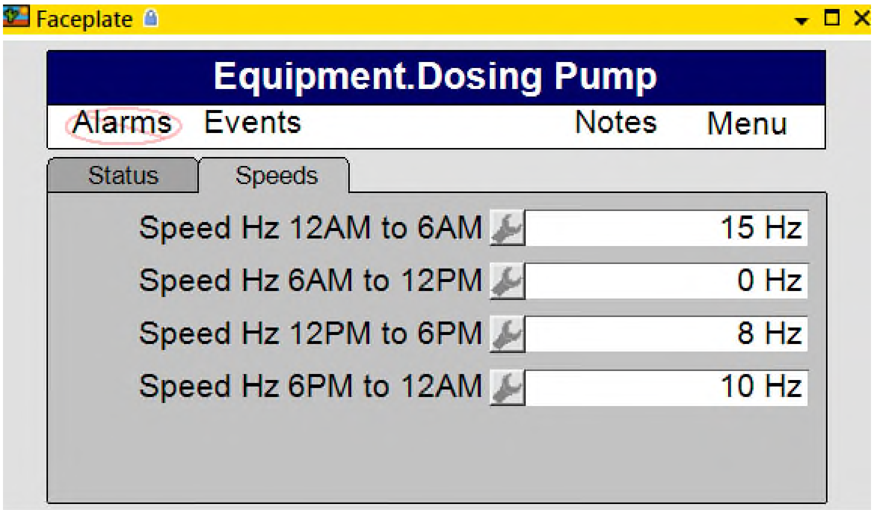


Figure 2: *SCADA output showing dosing pump speed and time settings*

2.3 Investigation

Once the hardware and software modifications had been made, the Sewer Optimisation Team set about testing various scenarios. As a first step, baseline levels of H_2S and pH were established for the sections of sewer downstream of the chemical dosing sites. Figure 3 shows a typical daily H_2S and pH trend with no chemical dosing upstream.

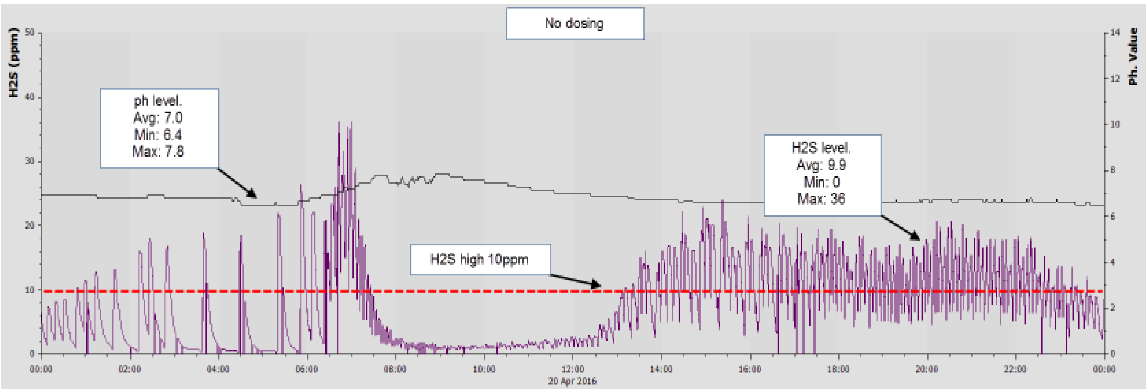


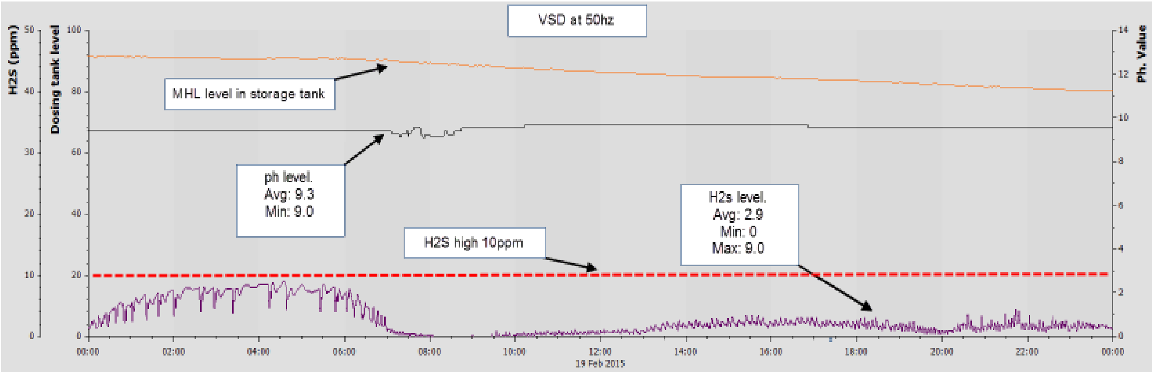
Figure 3: *Typical H2S and pH. levels with no chemical dosing upstream*

It was established that the sewage transfer time from the Chemical Dosing Facility to the downstream H_2S sensor was approximately 2 hours.

As can be seen in Figure 3, there are very low levels of H_2S in this part of the sewer system between the hours of 8am and 12pm, due to the high turnover of sewage in the network.

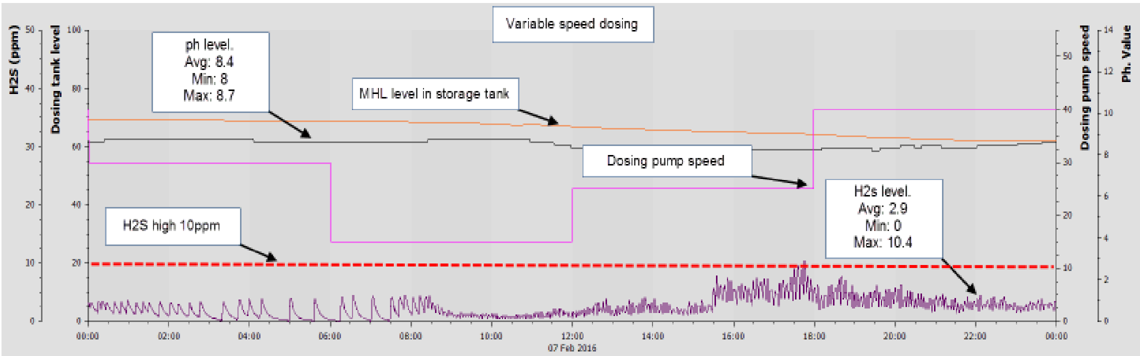
Note that H_2S levels above 10ppm are generally considered to be high, as no odour complaints were registered while H_2S levels were below 10ppm.

YVW quickly learned that its previous dosing regime was wasting significant quantities of MHL because the chemical did not need to be dosed during this time. Furthermore, YVW was dosing more of the chemical at this time, as a result of the volume-based method of dosing 100ml of MHL for every 1kL of sewage transferred by the SPS. This equated to 28% of the total volume of MHL used by the facility in a day being used during a period where no chemical dosing was required.



<u>Figure 4:</u> ***H2S and pH. levels with volume-based dosing***

YVW then assessed the impact on the levels of H_2S and pH in the downstream section of sewer by running the pumps at full speed (i.e. the original volume-based dosing regime). This impact is shown in Figure 4. While dosing at this rate, the Chemical Dosing Facility was using 1,500 litres of MHL every week.



<u>Figure 5:</u> ***H2S and pH. levels with flow-based dosing***

YVW then assessed the impact on the levels of H_2S and pH in the downstream section of sewer by running the pumps at variable speeds (i.e. the flow-based dosing regime). Figure 5 shows how the system responded to this more efficient variable speed dosing regime. When dosing at this new variable rate, the facility was using 1,500 litres of MHL per fortnight in summer and 1,500 litres per month in winter.

In order to fully optimise the flow-based dosing regime, incremental increases in dosing pump speed were made in order to prevent downstream H_2S levels from reaching 10ppm. It was found that more MHL was required during periods of low flow, and less MHL was required during periods of high flow. Temperature also played a part in optimising the new dosing philosophy as warmer sewer temperatures are more conducive to H_2S production.

When monitoring H_2S in the downstream sewer network, it became evident that H_2S levels were peaking and dipping up to four times per day. Four time blocks of six hour intervals were established to give the Sewer Optimisation Team the ability to set four different dosing pump speeds in a 24 hour period (as seen in Figure 2). The final dosing speeds and time settings can be seen in Table 1.

Table 1: *Winter and Summer VSD and time settings*

Time	Winter VSD speeds	Summer VSD speeds
12am – 6am	20Hz	30Hz
6am – 12pm	0Hz	15Hz
12pm – 6pm	10Hz	25Hz
6pm – 12am	10Hz	40Hz

2.4 Results of trials

The key results from the investigations are shown in Table 2 to Table 4.

Table 2: *Dosing rates and impacts on pH*

Dosing method	Min pH	Max pH	Ave pH
Volume-based (Fixed Speed)	9.0	9.6	9.3
No dosing	6.4	7.8	7
Flow-based (Variable Speed)	8.7	8.7	8.4

Table 3: *Dosing rates and impacts on H_2S*

Dosing method	Min H_2S	Max H_2S	Ave H_2S
Volume-based (Fixed Speed)	0	9	2.9
No dosing	0	36	9.9
Flow-based (Variable Speed)	0	10.4	2.9

Table 4: *Dosing rates and refill frequency*

Tank refill frequency	Summer	Winter	Tank fills per year
Volume-based (Fixed Speed)	Weekly	Weekly	52
Flow-based (Variable Speed)	Fortnightly	Monthly	20

The above results show how the Sewer Optimisation Team successfully managed to reduce the usage of MHL chemical, while not adversely impacting the customers or assets downstream of the MHL dosing facilities.

Once this newly adapted dosing regime had been rolled out across four of its MHL dosing facilities, YVW managed to reduce costs in procuring MHL by $80,000 in the 2015/16 financial year. This is shown in Figure 6.

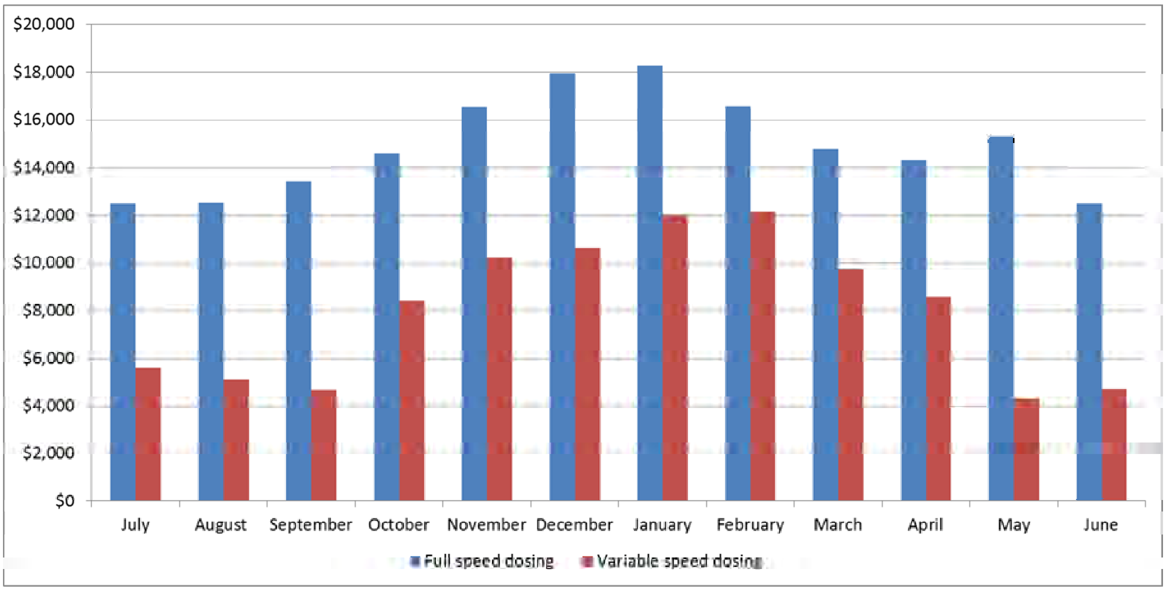


Figure 6: ***Monthly MHL cost comparison***

3. CONCLUSION

The main conclusions of this investigation are summarised as follows:

- Volume-based chemical dosing regimes are inefficient and costly.
- Flow-based chemical dosing regimes can achieve major cost savings without negatively impacting customers or asset life.
- Monitoring the behaviour of pH and H_2S levels in the network downstream of Chemical Dosing Facilities is vital to ensure that MHL dosing rates are fully optimised.
- Variable Speed Drives are required on dosing pumps to ensure that dosing can be controlled in an effective manner.
- The use of SCADA to provide remote access to speed references on dosing pumps negates the need for technicians to attend site.
- Each individual dosing facility will have its own H_2S profile depending on where the facility is located in the network. It is important to understand the baseline trends of these parameters before providing an optimised dosing solution.

4.0 ACKNOWLEDGEMENTS

I would like to thank a few people for their assistance during this investigation. Firstly, the assistance of Gavan Dowal of the YVW SCADA Team was invaluable, as he assisted with the configuration of the hardware and software of the Chemical Dosing Facilities. Secondly, David White, the YVW Water Optimisation Team's Specialist, taught me a great deal about how these systems work.