A CASE STUDY OF SEWAGE ODOUR AND CORROSION CONTROL IN NORTH QUEENSLAND

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ABSTRACT

Burdekin Shire Council is located between Townsville and Bowen in North Queensland. It covers an area of 5,053 km^2 and has a population of around 18,500 people. Ayr is the largest town with a population of around 8,500.

Like most towns across Australia, sewage odour and the consequent infrastructure corrosion is a serious concern. Sewage odour is a significant OH&S risk, while sewage infrastructure corrosion rates and consequent failure are a high cost for the Shire.

In an endeavour to tackle the OH&S Risk from sewage odour and its associated infrastructure corrosion cost, Burdekin Shire Council has trialled a number of dosing systems with varying degrees of success. The current dosing system employed minimises the OH&S risk from sewage odour, has eliminated odour complaints from the dosed area of the system and minimised infrastructure corrosion.

KEY WORDS

Sewage, Odour, Corrosion, OH&S Risk

1.0 INTRODUCTION

Burdekin Shire Council has existed since 1888. It is located in dry tropics between Townsville and Bowen. The shire covers an area of 5,052km^2 and the population has remained relatively unchanged since the mid 1960's at around 18,000.

The shires key industries include; sugar cane, melons, mangoes and prawn farming. The area is also very popular for fishing, scuba diving on the SS Yongala wreck and the heritage listed World War II radar site at Charlies Hill.

Burdekin Shire is situated in the delta of the Burdekin River where the topography is virtually flat. The towns are built on almost pure river sand, which can liquefy when wet. The shire has 127km of gravity sewer mains with a replacement value of $24 million, 32 km of rising mains with a replacement value of $4.2 million (common effluent and overflow mains). The council has 31 pump stations in Ayr, 7 in Brandon and 11 in Home Hill.

Higher than usual ground water levels from a huge wet season early in 2008, caused the failure of a number of sewer pipes and a manhole. During the dry, sewers held their own weight, however as the ground water rose, the sand liquefied and the corroded pipe work failed. Additionally a manhole at a different location failed as well on the same day. In Ayr, 345 metres of 150mm AC main collapsed in MacMillian St. This section of main had to be exposed and then bypassed. From the condition of the exposed AC main, it was obvious that the pipe needed to be relined as soon as possible with a PVC liner before the sewer could be reinstated.

On the same day as the above catastrophe, a 5 metre deep manhole on the end of a 225mm main moved breaking the main in Chippendale St. The manhole was removed and rebuilt and 260 metres of sewer relined. Ground water levels made it almost impossible to work even though dewatering pumps were setup. Then early 2009 another 225mm main failed in Cox St. East Ayr and was replaced with a PVC main.

A $500,000 a year relining program is now in-place. This allocation is reflective of the corrosive damage caused by H_2S gas. It is evident that corrosion is increasing in the gravity fed sewers. Increased attention now needs to focus on failures in rising mains where we believe the problem stems. Burdekin Shire Council is implementing a dosing strategy to control odour and corrosion in problem rising mains, using Biosol products.

The net cost of sewer pipe and manhole repairs / replacement from July 2004 to March 2011 is $ 1,429,000. This is a very significant cost for a small community.

2.0 DISCUSSION

Sewage odour causes infrastructure corrosion and represents a significant OH&S risk.

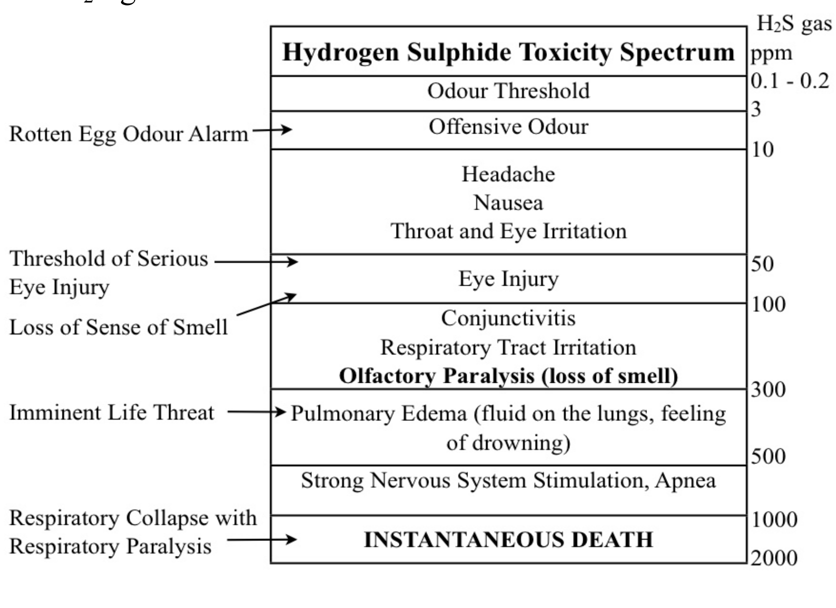
2.1 Sewage Odour and Corrosion

Hydrogen sulphide (H_2S or rotten egg) gas is formed by the breakdown of organic matter in the sewer under anaerobic conditions. Mori.T. et.al., determined that H_2S gas is formed in the biofilm / sediment layer at the base of the sewer pipe.

Bowker.R. et.al. states, "in collection systems, the major causative agent of corrosion is sulphuric acid formed from oxidation of H_2S gas in the presence of moisture." This sulphuric acid is responsible for the bulk of the sewage infrastructure corrosion.

2.2 Sewage Odour – OH&S Risk

Figure 1 shows the risk associated with various levels of sewage odour. The main odour of concern is H_2S gas.



<u>**Figure 1:**</u> ***Hydrogen Sulfide Toxicity Spectrum***

Figure 2 below shows the H_2S gas level at the end of a rising main in Ayr. The graph shows odour levels exceeding 200ppm on many occasions. Based on the H_2S Toxicity Spectrum, the peak odour levels represent an imminent threat to life. The operator would most likely not smell the odour and there is a serious risk of eye injury. These high H_2S gas levels represent a significant OH&S risk to operators.

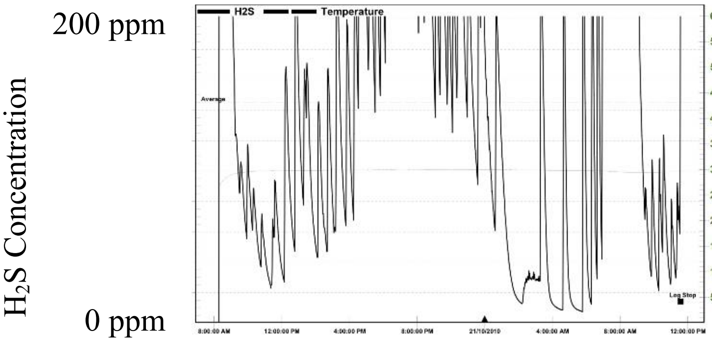


Figure 2: ***H_2S gas monitoring at the end of a rising main at Ayr***

2.3 Managing Sewage Odour

There are two main options to manage sewage odour, you can treat the cause of the sewage odour by dosing to the sewer, or you can treat the symptom by using scrubbers or other odour filter devices.

Treating the symptom will generally stop odour complaints, however high levels of odour will remain within the system, which is an OH&S risk. The sewage odour will lead to infrastructure corrosion and failure. Treating the cause of sewage odour should reduce the OH&S risk, the rate of infrastructure corrosion and consequent sewer failure.

2.4 Strategies to Treat Sewage Odour

There is an array of sewage odour control products on the market**,** many of which are either ineffectual or partially effectual. Many of the products have adverse side effects either in the sewage catchment or at the treatment plant. This has resulted in reluctance by some councils and water authorities to control sewage odour.

The odour control products range from oxygen injection, oxygenating chemicals such as calcium nitrate, to pH adjusting chemicals such as magnesium hydroxide, to reacting chemicals such as ferric salts. There are many other products that broadly fit into one or more of the following: enzymes, micronutrients or bacteria additives. While these enzymes, micronutrients or bacteria additives may be good for FOG (fat, oil and grease) removal at wet wells, experience shows they are relatively ineffectual at controlling sewage odour.

Biosol products do not fit into the above categories. Biosol works by removing the biofilm (slime layer) where odour is formed in the sewer. Biosol® products force the bacteria to move from a biofilm state where sewage odour is produced, to a single cell planktonic state where minimal odour is produced. This is backed up by a secondary dosing system that interferes with the metabolic rate (feeding) of sulfur reducing and methane forming bacteria. Biosol products are more cost effective than oxygen sources and pH raising chemicals. They are simple to dose, offer superior odour control and require a much smaller dosing site. Biosol products are believed to assist in improving effluent quality and reducing sludge volumes.

2.5 Burdekin Shire Council - Dosing History

Like most water authorities and shire councils, Burdekin Shire Council has tried a number of sewage odour control products. These have included ProBac (HydroBac) and Actizime. The following graphs are indicative of the levels of odour control achieved using these products.

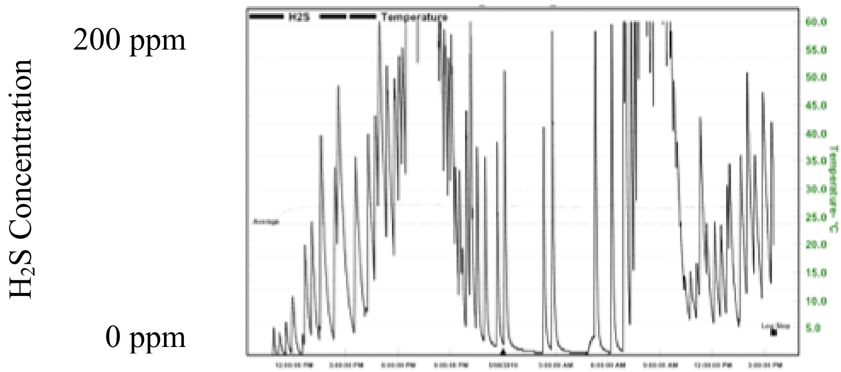


Figure 3: ***H_2S gas monitoring at the end of a rising main at Ayr – ProBac dosing***

Figure 3 shows the impact of ProBac on odour control. It is evident that some of the peaks well exceed 200ppm H2S gas.

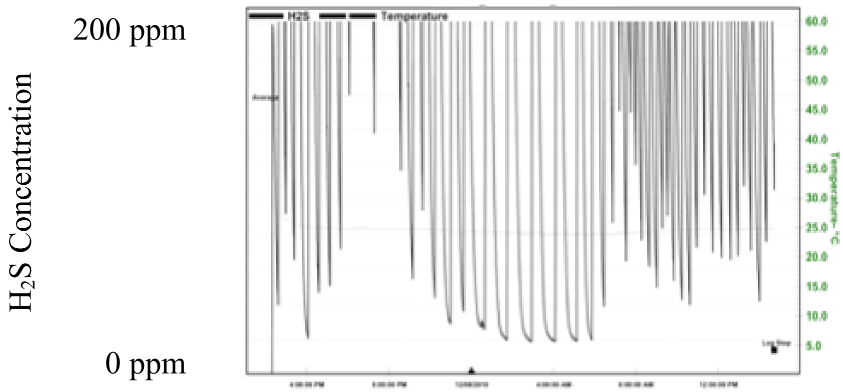


Figure 4: ***H_2S gas monitoring at the end of a rising main at Ayr – Actizime dosing***

Figure 4 shows the impact of Actizime on odour control. It is evident that most of the peaks well exceed 200ppm H_2S gas.

The above graphs show poor odour control using Actizime and ProBac.

Ground temperatures at Ayr are around 25 ^{o}C – 30^{o}C, which means there is a high odour generation potential within the sewers.

2.6 Dosing Solution

Figure 5 below shows why Burdekin Shire Council is now using Biosol for odour and corrosion control. When compared with pre-dosing odour levels, Biosol products have reduced the daily average odour by 98% and peak odour levels by 96% at the end of the SPS 5 rising main.

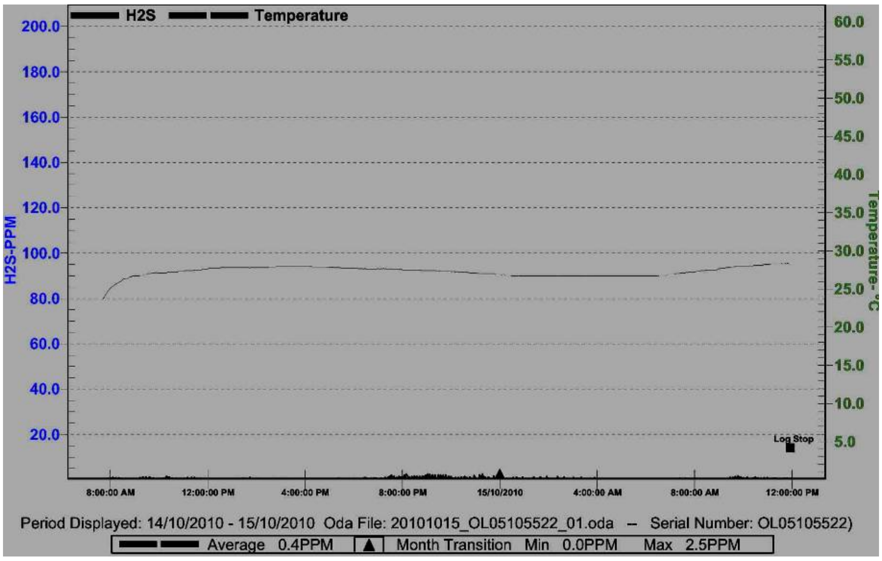


Figure 5: ***H_2S gas monitoring at the end of the SPS 5 rising main at Ayr – Biosol dosing. Average daily odour has been reduced to 0.4ppm and peak to 2.5ppm.***

2.7 Pomeroy's Corrosion Model

Dr. Richard Pomeroy was employed by the US EPA to estimate the cost of corrosion on concrete gravity sewer mains. He produced a corrosion model. Biosol have this model on the web at: http://www.biosol.net/corrosionmod/CorrosionModel.html.

The following tables are outputs from the Pomeroy model on the Web. The network inputs provided were: Burdekin Shire Council, 127 km concrete sewer mains, valued at $24 million, the average internal pipe diameter was assumed at 225mm and we have assumed pipe replacement was needed when the wall thickness decreased by 15mm. The sewers serviced an estimated population of 14,000. The average sewage characteristics assumed were, pH 7 meaning 50% of sulfides were dissolved and 50% were H_2S, the pipe is 50% full, the hydraulic gradient was 0.0012, flow velocity was 0.6 m/s, the Vcalc was 0.3912 m/s and sewer mains were asbestos cement with an acid reaction potential of 0.4

The dissolved sulfide inputs modeled were 0.5ppm, 2ppm and 6ppm. The results give an estimate of the likely loss of pipe wall thickness and years to failure as well as the estimated cost / person / year.

Outputs

Pipe thickness lost each year:	0.27	mm / annum
Years to failure:	55.5	Years to failure
Equivilent kilometers lost per year:	2.3	km / year
Cost of kilometers lost:	432,400	(Aus) $ / year
Cost per person:	30.89	(Aus) $ / person / year

Figure 6 shows the sewer with a design life of 55.5 years based on 2ppm dissolved sulfides. The cost of corrosion is about $31.00/ person/ year. This is about ½ of what the water industry network estimates in the USA.

Figure 6: ***Dissolves sulfides 2ppm***

Outputs

Pipe thickness lost each year:	0.07	mm / annum
Years to failure:	222	Years to failure
Equivilent kilometers lost per year:	0.6	km / year
Cost of kilometers lost:	108,100	(Aus) $ / year
Cost per person:	7.72	(Aus) $ / person / year

Figure 7 shows how appropriate dosing to control dissolved sulfides in the sewer can substantially reduce the cost of corrosion and substantially increase asset life.

Figure 7: ***Dissolves sulfides 0.5ppm***

Outputs

Pipe thickness lost each year:	0.81	mm / annum
Years to failure:	18.5	Years to failure
Equivilent kilometers lost per year:	6.9	km / year
Cost of kilometers lost:	1,297,000	(Aus) $ / year
Cost per person:	92.67	(Aus) $ / person / year

Figure 8 shows the cost increases to almost $93/person / year, when the dissolved sulfides are around 6ppm and sewer failure occurs in about 18.5 years instead of the design life of around 55 years.

Figure 8: ***Dissolves sulfides 6ppm***

3.0 CONCLUSION

Biosol® products have proven to be far superior to all other products tried by the Burdekin Shire Council in minimizing H_2S gas levels. Daily average H_2S gas levels at the end of the SPS 5 rising main have been reduced by 98% to around 0.4ppm and peak odour levels by 96% to around 2.5ppm. These gas levels represent a minimal risk to staff.

Burdekin Shire Council has suffered from insidious infrastructure corrosion from high level of H_2S gas, which led to substantive sewer failures. Treating the cause of sewage odour with appropriate technology such as Biosol® will substantially increase infrastructure asset life.

Figure 6 and Figure 7 show how the cost of infrastructure corrosion is reduced from around $31.00 /person /year to around $8.00/ person / year when dissolved sulfides are reduced from 2ppm to 0.5ppm. If the cost to achieve this level of odour reduction is $7.00/ person / year, it represents a ROI in terms of corrosion of $2.00 for every $1.00 invested in odour control.

4.0 ACKNOWLEDGEMENTS

Burdekin Shire Council and in particular Gary Tickner, for providing the information contained in this paper.

5.0 REFERENCES

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