MICROBIAL CONTROL IN WASTEWATER SYSTEMS

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ABSTRACT

Since microbes are responsible for odour and corrosion problems in sewage catchments, it makes sense to elicit a control over the responsible microbes. This can be achieved by 'down regulating' or slowing down the bacteria in the sewage catchment, using cell-signalling technology.

The down regulation of the microbes can be used to cause the disintegration of the biofilm / sediment complexes within the pipes as well as bacterial flocks that may form in pressure mains. This down regulation of microbes treats the cause of sewage odour generation and has a theoretical odour reduction of >99%.

As microbes are responsible for sewage process, manipulating microbes to enhance sewage process is equally logical.

1.0 INTRODUCTION

Odour and corrosion are major costs associated with sewer asset management. The AWWA currently estimates the cost of sewage infrastructure corrosion in the US, at **US$13.75 Billion/ annum**[1]. That equates to about US$ 46.00 / person / year.

It would be hard to imagine that the cost of sewage infrastructure corrosion in Australia would be much different to the US. **That means that the cost of sewage infrastructure corrosion would be around A$ 53.00 / person / year in Australia**. In most cases the true cost of sewage infrastructure corrosion is not accounted for.

Out of sight means out of mind, at least until a catastrophic sewer failure occurs.

This is caused by;

Photo Courtesy of Griffith City Council

This

[1] http://www.corrosioncost.com/pdf/water.pdf (Pg3)

This reduces the likelihood of;

Photo Courtesy Griffith City Council

This

Catastrophic sewer failures reflect badly on the management of sewer infrastructure, but they are remarkably common in most developed countries.

Sewerage odour is generated in the biofilm (bacterial slimes) that grow in all sewer systems as shown below.

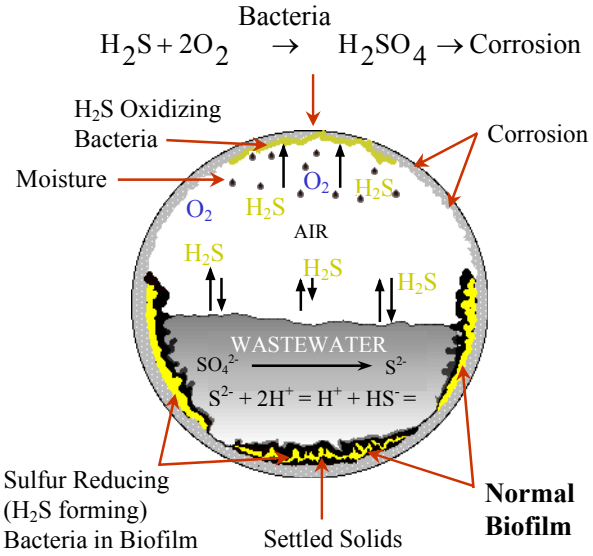

Figure 4: The process of H_2S odour generation and corrosion in sewers

2.0 SEWAGE ODOUR CONTROL

2.1 Traditional methods of odour control

Odour control in sewers normally rely on adding:

- Oxygen, or sources of oxygen to the sewage,
- Reacting chemicals that react with the sulfides to form insoluble compounds.
- pH adjusting chemicals. These increase the pH to reduce the gaseous H_2S odour in the sewer.
- Biocides. These are used to kill all the bacteria in the system and thus control odour.

2.2 Microbial control

Microbial control offers a new, **natural solution** for tackling the problem of odour generation, corrosion and consequent sewer failure. **Microbial control is used to treat the cause of the problem and not the symptom.**

How does microbial control work in nature?

In nature, bacteria generally exist in one of two forms. They exist in either a single cell (planktonic) form, or a biofilm form. Bacteria form biofilms to better utilise a food resource. Biofilms can be thought of as an **up-regulated** state where the bacteria's metabolic[2], respiration and reproduction rate are optimised. It is also the state in which about 99% of odour generation can occur within a sewerage catchment.

By contrast, bacteria in a **down-regulated** state can be likened to animals hibernating. They lower their respiration, metabolic and reproduction rates. In this condition the sewage remains fresher for longer as the oxygen consumed by the microbes is minimised.

The above are natural conditions in which bacteria move from a planktonic state to a biofilm form and back to a planktonic state again. This movement between the biofilm and planktonic state is largely dependant on available food resources and environmental conditions.

How do bacteria know when to move from one form to another?

In 1996 it was first recognised that bacteria **"talk"** to one another. A fundamental point in this talk has to be reached before bacteria can form a biofilm. This fundamental point is known as **"Quorum Sensing"**. Bacteria talk is achieved through the use of what are known as **"cell signalling chemicals".** Bacterial talk and signal strength allows bacteria move in and out of the biofilm form.

Plants and animals have coevolved with bacteria and present an ideal food resource for the bacteria. As part of this coevolution, plants and animals have learnt to **talk** to the bacteria in their environment. This is achieved through the use of the same cell signalling chemicals bacteria use, mimics of those chemicals; or chemical signal blockers or scramblers that interfere with the bacteria's communication signals. These are the same chemical cell signals that Biosol use in their products.

Using Bacterial Talk in the Sewerage System?

In a sewage catchment, odour is generated within the anaerobic biofilm complex. Normal sediment deposition increases the biofilm/ sediment complex and the ecological niche for sulfur reducing bacteria. Hence the odour generation potential in the sewer is generally increased by sediment deposition.

Biosol use naturally occurring cell signalling chemicals (bacterial talk) or signal blockers that force the bacteria to break out of the biofilm form and resume a planktonic form. Under this scenario, the theoretical reduction in sewage odour generation is decreased by 99%. Biosol have quantified reductions in $\mathbf{H_2S}$ gas as measured by OdaLog instruments as high as 94%[3]

[2] The rate at which bacteria use a food resource.

[3] Chandler.R., *Microbial Control Reduces Sulfides* "WATER" Volume 32, N0 2, March 2005 Published by Australian Water Association.

The photo shows the level of biofilm / sediment complex in a 600mm sewer main at Griffith NSW

Substantial quantities of H_2S gas would be forming in the anaerobic biofilm / sediment complex that can be seen across the base of the sewer pipe. This **H_2S** gas is then converted to sulfuric acid by ***Thiobacillus*** bacteria that colonise the roof of the pipe. Sulfuric acid runs down the walls of the pipe. It is the corrosion of the roof and walls of the pipe that cause the catastrophic sewer failure.

The application of specific cell signals and signal strengths, has caused the disintegration of the biofilm sediment complex across the base of the pipe as evident in the photo below.

The photo shows the same pipe (as above) at the same location 30 days after Biosol products were applied to the sewage.

Note the level of disintegration of the sediment / biofilm complex across the base of the pipe. This means that the cause of the odour generation and therefore corrosion has largely been removed. Note the improved reflective index of the pipe. The pipe has lost most of the spongy brown appearance it had 30 days before. It appears to be dryer with much less active corrosion occurring.

Richard Pomeroy's Corrosion Model (US EPA) suggests, that if you halve the level of dissolved sulfides in a concrete gravity main, you double that asset life. Removing the cause of odour generation will obviously substantially extend the infrastructure asset life such as sewer pipes, manholes and wet-wells from the impact of sulfuric acid induced corrosion. Corrosion cost savings from biofilm removal as shown above, based on the AWWA corrosion costs, Biosol estimated at greater than AUD $25.00 / person/year.

3.0 IMPACTS ON FAT, OIL & GREASE DEPOSITS

Research undertaken by Biosol, indicates that biofilms appear to be necessary for the adherence of fat, oil and grease to the sewer catchment pipes. What have been observed are large quantities of dislodged fat, oil and grease arriving at the sewage treatment plant, in every case where Biosol's microbial control products have been dosed to a sewer catchment.

4.0 OH&S IMPACTS

It is obvious that if you reduce or remove the cause of **H_2S** gas generation in the sewer, you will reduce the risk to employees exposed to this potentially hazardous and toxic gas.

Biosol's microbial control products are classified as non-hazardous to human health and have no known adverse environmental impacts.

5.0 SEWAGE PROCESS

The impacts of microbial control on sewage process
Since most sewage process is undertaken by microbes, it makes sense that if can talk to the microbes and lift their metabolic and reproduction rate, then sewage process will be faster. Biosol currently have products available that will improve sewage process.

The following graphs relate to heterotrophic or standard plate counts. The graph in Figure 2 show a 23-fold increase in aerobic microbial activity for the Biosol treated sewage when compared to the untreated sewage.

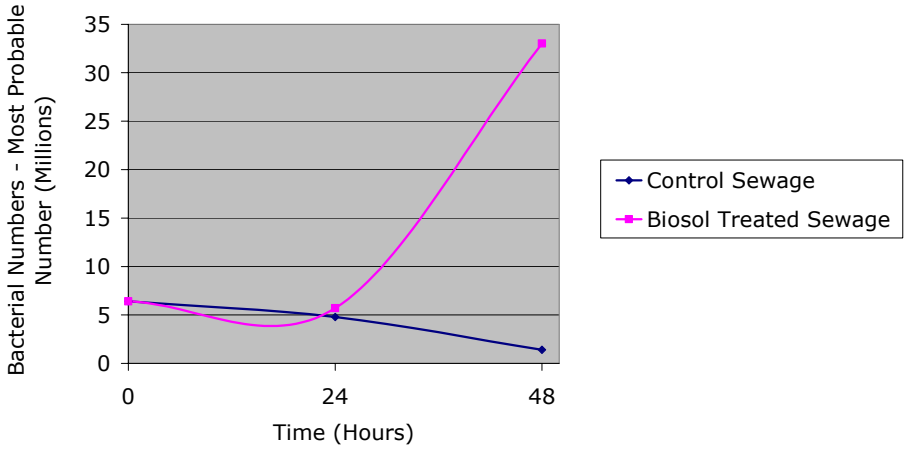

Figure 5: ***Heterotrophic plate count – Aerobic Bacteria Response***

Similarly Biosol's cell signalling products were able to lift the anaerobic microbial activity by 15 times when compared to that of the control (Figure 3 below).

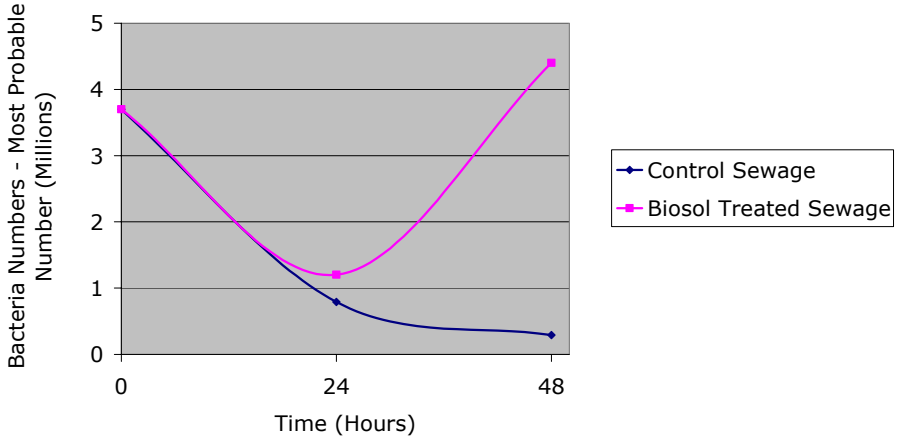

Figure 6: ***Heterotrophic plate count – Anaerobic Bacteria Response***

6.0 CURRENT MICROBIAL CONTROL RESEARCH

Currently Biosol are continuing research and documenting the use of microbial control products to:

- **Defer sewage treatment plant augmentation** through improved aerobic and anaerobic sewage digestion.
- **Increase methane gas production**, for capture and use as an energy source.
- **Improve biological nutrient removal of N & P**
- **Improve effluent quality**
- **Reduce biosolid volumes and handling costs**
- **Reduce greenhouse gas production**

All of the above areas of research are based on field observations.

7.0 CONCLUSION

The application of microbial control technology to wastewater systems, offers the greatest advance in wastewater management in the last 100 years.

"**Cell Signalling**" and "**Quorum Sensing**" are at the heart of microbial control technology and are among the fastest growing areas of biological science. Biosol holds patents and provisional patents over the use of this technology in wastewater systems.

If microbes cause the problem, then the answer to this problem lies in microbial control. **Biosol's technology is the application of nature's solutions for sustainable Wastewater Systems.**

Currently naturally derived products are available to control sewage odour and thereby minimise or prevent infrastructure corrosion caused from sulfuric acid. Additionally products are available that will improve sewage process, reduce biosolid volumes and assist with biological nutrient removal.