BIOFILTRATION FOR EMISSION AND ODOUR CONTROL

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9th Annual WIOA
NSW Water Industry Operations Conference and Exhibition
Orange PCYC,
24 to 26 March, 2015

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ABSTRACT

Odour management is a significant challenge for industrial and municipal operations. For several decades biofiltration has been used worldwide for emission and odour control. Because of its ability to adapt to a wide variety of Volatile Organic Compounds (VOC's) the technology has been applied across a range of industries. The classic quote from the movie Field of Dreams "If you build it they will come." is now perhaps over used but it neatly sums up the basic principal of the operation of biofilters. That is, appropriate bacteria will naturally colonise biofilter media in response to the VOC's that are introduced.

Biofilters have evolved from simple and crude soil beds to more refined soil beds, through to packaged biofilters that provide far greater control of critical media parameters such as moisture content and consistent air flow. Now a recent development refines the concept further, while substantially negating the issue of media degradation.

Three case studies are presented where traditional soil beds have been replaced with packaged biofilters resulting in vastly improved outcomes.

Note that this paper deals specifically with biofilters. The related technology of biotrickling filters entails an approach that is sufficiently diversified from conventional biofilter technology that it can be treated as a separate subject, and is not included in this paper.

1.0 INTRODUCTION

"Odours constitute the largest area of air quality related complaints for all Australian and New Zealand regulatory authorities." (Clean Air Society of Australia and New Zealand). It is generally accepted that there is no single panacea odour control technology. However biofiltration is regarded as a versatile solution due to its ability to adapt to a wide variety of Volatile Organic Compounds (VOC's), in that appropriate bacteria will naturally colonise biofilter media in response to the VOC's that are introduced.

Early biofilters were open bed (soil bed) type facilities. They were often poorly designed, had limited media options, required high-maintenance and subsequently often delivered poor performance. Over time soil beds evolved and improved but were still constrained by their fundamental design. The biofilter concept evolved further and was configured as a "packaged biofilter" with the media contained within a vessel. There has now been a specific development of packaged biofilter technology- FiltaOdor.

2.0 DISCUSSION

2.1 The Principal of Biofiltration

Bio-filtration is the removal and oxidation of VOC's by microorganisms. The air flows through a packed bed and the pollutant transfers into a material that is biologically active, the biomass. Microorganisms, including a consortium of bacteria and fungi, are immobilised in the biofilm and degrade the pollutant. An ideal environment must be maintained to ensure a robust biomass.

2.2 Key Operating Parameters - Comparison Of Soil Beds With Filtaodor

Below is a comparison of soil beds with the FiltaOdor biofilter in terms of the Key Operating Parameters. It is acknowledged that many packaged biofilter designs have addressed some of the shortcomings of soil beds to varying degrees, however the FiltaOdor design comprehensively addresses all shortcomings.

Table 1: ***Soil beds V Filtaodor – Key Operating Parameters***

SOIL BED	FILTAODOR
Air Flow	
Air flow resistance of media restricts media depth resulting in a large footprint to achieve the necessary media volume, and limiting where on site the soil bed can be positioned.	Very low air flow resistance of media allows a deep bed and small footprint thus providing greater flexibility for positioning on site.
Humidification & Irrigation	
Commonly rely on irrigation alone to maintain media moisture levels - typically timer based systems with lawn watering type sprinkler heads. No automated control of media moisture content.	Integrated humidifier / irrigation system. Moisture level is maintained at equilibrium via a process that allows excess moisture to fall out for recovery and recirculation. The media is not exposed to weather. Incorporates a "wobbler" sprayer, creating heavy droplets and an irregular spray pattern to provide even coverage.
Diffusion	
Typically have slotted pipes in granular bedding, subject to blocking with degraded organic media. Bark / woodchip based media is highly bioavailable and degrades rapidly, becoming compacted and restricting air flow. Also subject to weed growth, with roots interfering with air flow and often penetrating the slotted pipes.	Air flow introduced via an unrestricted void space (plenum). Media is a combination of an organic fibre and a mineral media working cohesively to create even diffusion and moisture retention. The media has very low biodegradability.
Media Interface	
If media is in direct contact with the granular bedding of the diffuser pipes material migrates through and blocks the pipes. If a separation layer such as geofabric is used to prevent this, the geofabric itself restricts air flow.	Incorporates a cored deck separating the media from the plenum. The deck has a specific aperture size and number to ensure there is no restriction or increase in air flow velocity. The media is placed directly on the deck with no need for any other separation layer. The media does not break down and allow migration of material through the deck.

Venting	
Slotted diffuser pipes need to be tuned to match the inlet ducting capacity and for even distribution across the diffuser pipe layout.	Inlet ducting size is designed for optimum air flow, open plenum allows even distribution, exhaust is via a correctly sized exhaust vent.
Managing Environmental Variances	
Open beds are exposed to seasonal temperature conditions. Wind causes variable evaporation rates that auto irrigation cannot accommodate. Media is subject to weed and vermin infestation.	The enclosed vessel facilitates a more consistent temperature average. Optimal moisture content is maintained. There is minimal seasonal impact. There is no weed or vermin infestation.

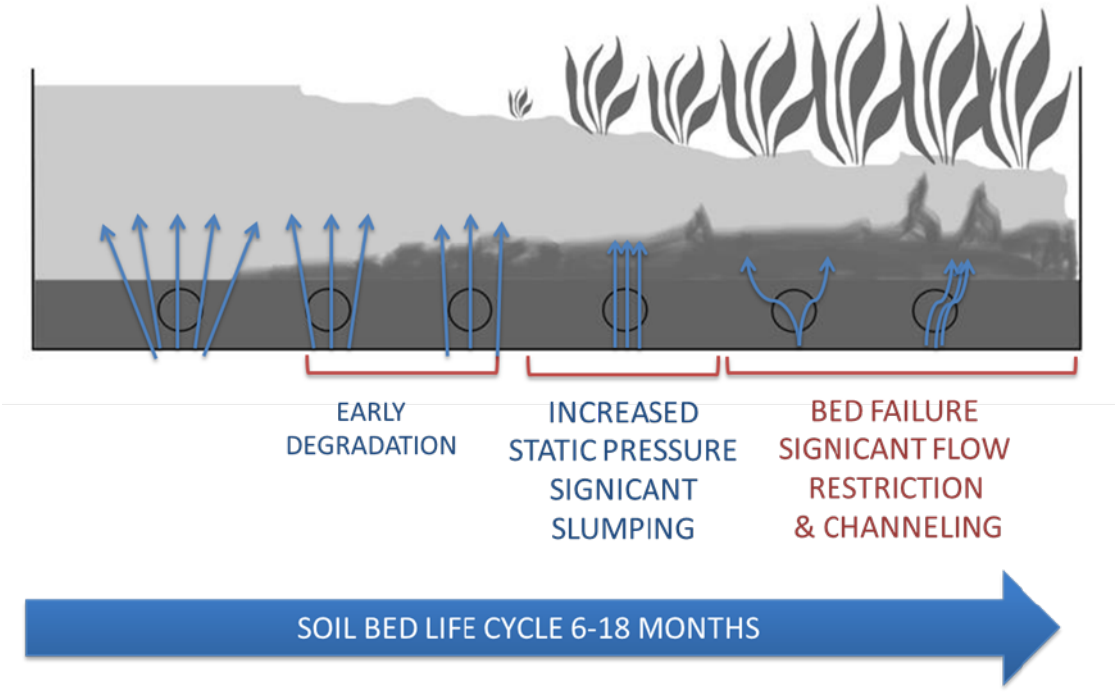

Figure 1: ***Typical Soil Bed Degradation***

2.3 Case Study 1 – Surf Beach Moruya

Eurowater based at Moruya in the Eurobodalla Shire on the NSW South Coast had an issue with odour emissions from one of their wastewater pump stations. The pump station is in a sensitive location right on a popular beach for tourists and locals, and there is a high-value housing estate on a ridge directly behind.

A number of different iterations of soil beds had been in operation at the site over several years, each working with limited success. The most recent soil bed had an extraction rate of 600 L/s and a footprint of 9M X 6M. When it became clear that optimisation options for the soil bed filter had been exhausted and an acceptable outcome was not going to be achieved Eurowater decided that a different approach was required. In consultation with OCS, a FiltaOdor packaged Hybrid biofilter concept was developed to replace the soil bed.

Given the highly sensitive nature of the site in terms of the long term issue for local residents and the impact on tourism, the council required an outcome that would achieve virtually zero odour emissions. It also needed to have minimal aesthetic impact to the beach-side site.

Consequently OCS proposed a hybrid filter comprising two biofilter vessels operating in parallel, and a small carbon filter polishing unit. Two smaller biofilter vessels were deemed to have less visual impact than one large unit. The biofilter vessels in unison were designed to remove approximately 95% of odours. The carbon filter was designed to deal with high odour "spikes" and achieve an overall odour removal rate of 99.9%. The extraction rate was the same as the soil bed at 600 L/s. The entire package had an overall footprint 60% smaller than the soil bed and was able to be set back into the embankment.

The hybrid filter was commissioned in July 2013 and immediately achieved excellent results. Simultaneous data logging of inlet and outlet H_2S concentrations shows a removal rate of >99%. These results were endorsed by comments from residents who had been complaining about odours for years and were now satisfied that the problem was solved.

Figure 2: ***Surf Beach Moruya – Old Soil Bed in Foreground with New Biofilter Behind***

2.4 Case Study 2 – Yamba

Clarence Valley Council on the NSW North Coast was receiving odour complaints from residents and tourists in relation to a wastewater pump station in Yamba. The pump station is located in a large and frequently used park that incorporates a neighbourhood garden. The garden is a council initiative to bring the community together and produce fruit, vegetables and local flora.

A conventional soil bed biofilter had been constructed on the site however it was not controlling the odour emissions effectively. Airflow was restricted due to compacted media, and the bed had been turfed which amplified the problem with roots binding up the media. Consequently gases were short circuiting to the sides of the bed. The bed had a large footprint that took up a significant portion of the park.

Council comprehensively resolved all issues by replacing the soil bed with a FiltaOdor packaged biofilter. Odour complaints ceased, maintenance requirements were virtually eliminated and a large area of the park was freed up.

Figure 3: ***Yamba – New Biofilter in Foreground with Old Soil Bed Behind***

2.5 Case Study 3 – Boat Harbour

Boat Harbour is in the Port Stephens region, North of Newcastle. Hunter Water had odour problems at Boat Harbour No.4 pump station since it was commissioned in the 1990's. In 2004 a soil bed biofilter was constructed at the site. It did provide some improvement but its performance was inconsistent. It was high maintenance, requiring regular weeding and media top-ups. Throughout its life complaints from surrounding residences persisted.

Figure 4: ***Boat Harbour – Old Soil Bed in Foreground with New Biofilter Behind and Adjacent to the Wet Well.***

In May 2014 the soil bed was replaced with a FiltaOdor packaged biofilter. After a short period while the microbial population established and humidification / irrigation was optimised, the packaged biofilter was able to achieve what the soil bed could not – consistent reliable odour control. Simultaneous data logging of inlet and outlet H_2S concentrations shows a removal rate of >99%. Positive comments were received from the surrounding residents that had been complaining for years. The old soil bed was demolished shortly after the above photograph was taken. This is a good example of how the smaller footprint of the biofilter allowed it to be positioned much closer to the wet well odour source.

3.0 CONCLUSION

The basic principal of biofiltration has always been sound. Microorganisms will naturally colonise a suitable media in response to the compounds that are introduced, allowing odours to be controlled by a natural process. However it has taken years of evolution to resolve all of the practical issues and develop a design where all of the vital parameters are controlled with little maintenance and consistent results are achieved long term. This is the outcome delivered by the FiltaOdor packaged biofilter.

4.0 ACKNOWLEDGEMENTS

Input for this paper was provided by Larry Botham of Bioaction Pty Ltd.