Odour Control Using Biofilters

Jiafa Luo and Albert van Oostrom
Meat Industry Research Institute of New Zealand, P.O. Box 617, Hamilton, New Zealand

INTRODUCTION

Approximately fourteen New Zealand animal rendering plants use biofilters to control odour emissions (Luo and van Oostrom, 1995). The rende process gases are treated as they pass through the biofilter medium, which may consist of wood bark, soil, peat, compost, or combinations of th substances. The odorous compounds are removed by a combination of physical, chemical and biological processes.

Generally, biofilters are very effective at removing odour from rendering emissions. However, odour removal performance can sometimes unreliable (Luo and van Oostrom, 1995). Poor biofilter performance may result from inadequate gas pre-treatment, uneven gas distribution moisture levels in the filter, and poor filter porosity, which causes high back-pressures.

MIRINZ has studied the performance of pilot-scale biofilters treating rendering gas emissions (Luo and van Oostrom, 1996). This paper prese results of monitoring the performance of three full-scale biofilters at two rendering plants.

METHODS

Rendering Plants and Biofilters

One of the plants (Plant 1) renders offal in a MIRINZ Low Temperature Rendering system (MLTR), and processes blood. The meat and bone m is dried in two direct-fired dryers. The biofilters at this site treat the exhaust gases from the dryers, after dust removal in a cyclone separator, a cooling through a heat recovery system and condensers. Two types of biofilter are used: Biofilter 1, which was constructed in 1990, consists o 0.6 m deep layer of pit-sand; Biofilter 2, which was constructed in early 1997, consists of a 1.1 m deep layer of crushed pine (*Pinus radiata*) ba

The other plant (Plant 2) renders a range of raw materials including fallen stock, offal, blood and feathers. Several technologies are used, includi batch cookers, disc dryers and a direct-fired ring dryer. After passing through condensers, the process gases are treated in a biofilter (Biofilter The biofilter system was constructed in 1987, and originally consisted of a 1 m deep layer of peat. The peat medium was replaced with a mixtu of bark and soil in 1992.

For all the biofilters, the gases pass vertically through the filter layer. The air distribution system below the filter layer consists of a network perforated pipes buried in a layer of coarse gravel. The biofilters are outdoors and uncovered. Temperature of the biofilter influent gas is abo 30-40°C for all these biofilters.

Loading Rates and Pressure Drop

Biofilter loading rates were determined by measuring gas flow velocities in the inlet pipe of the each biofilter, using an air velocity meter (Mode 443M, Kurz Instruments Inc.). The rates were estimated based on the volume of biofilter medium. Static pressures in the influent pipe and bo of the biofilters were measured using water-filled U-tube manometers.

Odour Removal

Biofilter influent gas samples were collected from the influent pipes, and several effluent gas samples were collected from randomly selected sit on the biofilter surface. The effluent samples were collected from within a stainless-steel sampling chamber, whose base was pressed about 50 m into the top of the biofilter. The cone-shaped chamber has a 1 m^2 base area, and the effluent gas discharges through an 81 mm opening at the to of the chamber. The gas discharge rate from the sampling chamber, and thus from the biofilter surface, was measured at each sampling locatio using the air velocity meter.

To assess the removal of individual compounds through the biofilters, influent and effluent gas samples were analysed using a gas chromatograph mass spectrometer (GC-MS) and a GC fitted with an odour sniffing port (Luo and van Oostrom, 1996). Forced-choice dynamic-dilution olfactomet was used to assess overall odour removal by the biofilters. The olfactometers were designed and operated under the Dutch pre-standard for senso odour measurements (Dutch Normalisation Institute, 1990). Odour concentration was expressed as odour units (OU) m^{-3}

RESULTS AND DISCUSSION

Odour Compounds and their Removals

The GC-MS chromatograms revealed that the rendering of animal tissues liberated over 300 organic compounds. Using the odour port technique we detected between 20 and 50 odorous compounds in the influent gas to the biofilters. The odorous compounds included alkanes, alkenes, ketones hydrocarbons, epoxides, aldehydes, aromatics, alcohols, amines, alkyl halides and fatty acids. A variety of odour characters was present in the rendering process gases, and the odour characters varied between the two plants, reflecting the different material types rendered.

Some of the odorous compounds in the biofilter influent gases were detected in the effluent gas, but their concentrations were reduced by at leas 90%, and sometimes by more than 99%. Similar results were found for pilot-scale biofilters operated at the same sites (Luo and van Oostrom, 1996 Also, some odorous compounds detected in the biofilter effluent were not in the influent. These compounds may have come from the biofilter medi or from the breakdown or conversion of organic compounds present in the influent gases in the biofilter media.

The rendering process gas at Plant 2 had a distinct ammonia odour. On one occasion the biofilter influent and effluent ammonia concentrations were measured, and found to be 55 and < 0.1 mg NH_3-N m^{-3}, respectively. Thus, the ammonia was readily removed by the biofilter. The ammonia leve in the process gas at Plant 1 was less than 1 mg NH_3-N m^{-3}.

Date	Influent gas		Effluent gas		Mean odour reduction (%)
	Gas loading rate (m^3 m^{-3} h^{-1})	Odour conc. (OU m^{-3})	Number of samples	Mean odour conc. (OU m^{-3})	
Biofilter 1 (pit-sand) at Plant 1					
16 Jun 95	22.5	430,000	3	46,000	89
12 Feb 96	20.5	1,000,000	8	120,000	88
16 Feb 96	16.4	630,000	5	100,000	84
Biofilter 2 (pine bark) at Plant 1					
26 Jan 97	5.9	59,000	2	10,500	82
04 Mar 97	4.2	141,000	3	9,700	93
05 Mar 97	3.8	203,000	4	6,000	97
Biofilter 3 (soil/bark) at Plant 2					
14 Feb 96	1.1	570,000	4	36,000	94
15 Feb 96	2.7	450,000	4	25,000	94
06 Mar 97	8.0	387,000	4	2,600	99

Table 1.
Odour removal by biofilters

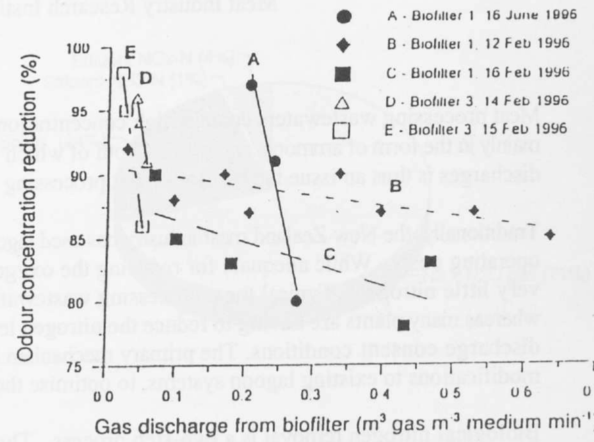

Figure 1.
Odour concentration reduction and local gas loading at random sampling sites on Biofilter 1 and Biofilter 3.

Odour Levels and Reduction

Biofilter influent gas odour concentrations, as measured by olfactometry, ranged between 59,000 and 1,000,000 OU m^{-3} over various biofilter loading rates (Table 1). The biofilters reduced the odour concentration by 82 to 99%. The odour concentration removal performance was similar to that of pilot-scale biofilters installed at the same sites (Luo and van Oostrom, 1996).

For Biofilter 1 (pit-sand) and Biofilter 3 (soil/bark), the reduction in odour concentration varied between random gas sampling sites (examples are given in Figure 1). The lowest rates of odour concentration reduction in the biofilters were associated with sampling sites that had high gas discharge rates. The uneven gas distribution is thought to have been caused by uneven air distribution under the biofilters, as well as by irregular depths or inconsistent density of the media.

The nuisance effect of an odour discharge depends on the odour's FIDOL factors: Frequency, Intensity, Duration, Offensiveness and Location. The reduction in *intensity* of the biofilter discharge, as measured by olfactometry, is therefore not the only factor to consider when assessing the biofilter performance. A reduction in the *offensiveness* of the gas is also important. The biofilter discharge gas was sniffed in the sampling chamber before it escaped to the atmosphere. The character of this gas was considered inoffensive in contrast to the influent gas, which smelled somewhat putrid and very smoky. The odour concentration reductions therefore underestimate the performance of the biofilters in terms of reducing the nuisance potential of the gas.

Pressure Drop

The pressure drop across Biofilters 1 (pit-sand) and 3 (soil/bark) often became excessive (higher than 150 mm water gauge). (The gas loading rates shown in Table 1 are typical for these biofilters.) The high back-pressure reduced gas flow rates to the biofilters, affecting the performance of direct-fired dryers. The media of these biofilters had to be loosened often, to reduce the back-pressure. Biofilter 2, containing crushed pine bark, operated with a low very back pressure (less than 2 mm water gauge), even when the bark was saturated with water after heavy rainfall and irrigation.

CONCLUSIONS

The rendering of animal tissues liberated over 300 compounds, of which about 20-50 were odorous. The rendering process odour was attributed to a variety of compounds such as alkanes, alkenes, ketones, amines, aromatics, fatty acids and ammonia. Biofiltration either removed these odorous compounds or significantly reduced their concentrations.

The rendering process gases had odour concentrations of between 59,000 and 1,000,000 OU m^{-3}. The biofilters reduced the odour concentration by 82-99%, and reduced the "offensiveness" of the odour. Uneven gas distribution affected biofilter odour-removal performance.

The pit-sand and soil/bark biofilters produced excessively high back-pressures. Further time is needed to determine whether the bark biofilter will sustain its very low pressure drop and good performance.

ACKNOWLEDGEMENTS

This work was funded by the New Zealand Meat Research and Development Council. The companies that provided access to the biofilters for our study are thanked. Olfactometry analyses were conducted by Lincoln Environmental, Canterbury, and SGS Laboratories, Auckland.

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