



A Biotrickling Filter for Removing Ammonia and Odour in Ventilation Air from a Unit with Growing-Finishing Pigs

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Abstract

The present study was carried out to investigate the ammonia and odour removal with a commercial biotrickling filter (SKOV A/S, Glyngøre, Denmark) in a unit with growing-finishing pigs. The results demonstrated that the filter significantly reduced the ammonia concentration (ppm) in the outlet air ($P < 0.05$). Even though, the ammonia concentration before the filter ranged between 8.1 and 9.0 ppm during the winter period and 4.1 and 5.9 ppm during the summer period, the ammonia concentration after the filter was in the range of 1.2 to 2.4 ppm during the entire study. The filter significantly reduced the odour concentration (OU_E/m^3) in the outlet air ($P < 0.05$). However, there were large variations in the odour removal efficiency, which ranged from an average of 54 % during the winter period and 28 % during the summer period. A possible explanation for the reduced odour removal efficiency during the summer was the increased ventilation rate, which reduced the retention time of the outlet air in the filter. It was observed that some areas on the filter were clogged up with dust and biofilm and this may also have impaired the odour removal. In conclusion, the filter was able to reduce the ammonia and odour concentrations in the outlet air from a unit with growing-finishing pigs. However, it is required to improve the odour removal efficiency and to find methods to increase the retention time and prevent the clogging with dust and biofilm.

Introduction

In recent years there has been a growing interest in reducing ammonia and odour from pig production in Denmark. In Denmark, the main research areas are reduction at the source, which means slurry and wet surfaces in the pig production unit and chemical and biological cleaning of ventilation air. A biotrickling filter is one of the promising methods for reducing both ammonia and odour from the ventilation air. It was reviewed by Melse and Ogink (2005) that biotrickling filters have a greater ability for removing odour compared with acid scrubbers, whereas acid scrubbers have a greater ability for ammonia removal. The present study was carried out to investigate the ammonia and odour removal with a commercial biotrickling filter (SKOV A/S, Glyngøre, Denmark) in a unit with growing-finishing pigs.

Methods

A unit for 416 growing-finishing pigs with partially slatted floor was used. The study lasted for one year and during this period four batches of pigs were produced. Two biotrickling filters were placed in two separated filter rooms in each side of the unit (filter rooms 1 and 2). The ventilation system was based on the principle of negative pressure ventilation. Fresh air entered the unit through a diffuse inlet in the ceiling. The outlet air was sucked out from the slurry channels and into ventilation channels under the solid floor in each side of the unit. The ventilation channels were connected to the filter rooms. The ventilation fan was placed on the clean side of the filter and the outlet air was drawn through the filter. The filter was composed by two vertical cellulose pads, which were continuously humidified with water. As the outlet air passed through the cellulose pads dust, ammonia and odour compounds in the air stream were degraded and metabolized by the biofilm on the pads.

Odour samples were collected in Tedlar[®] odour bags with a volume of 30 L. The bags were placed in an airtight container and filled by creating an underpressure in the airtight container by means of a pump. In each batch, four to six pair wise odour samples were taken from the air stream before and after the filter in filter room 1. Collection of odour samples and analyses of odour concentration (OU_E/m^3) took place in compliance with European olfactometric standard EN13725 (CEN, 2003). Ammonia concentration (ppm) was measured in the air stream before and after the filters using a Dräger Polytron 1 (Dräger Safety AG & Co. KGaA, Luebeck, Germany). The Dräger Polytron 1 was integrated in a VE 18 Multisensor

(VengSystem, Roslev, Denmark). The VE 18 Multisensor sampled at a flow rate of approximately 1-2 L/min and switched between outdoor air and the air stream before and after the filters. In the VE 18 Multisensor, sampled air was pre-heated to 34 °C before entering the Dräger Polytron 1. The measurement of ammonia concentration was logged at 1 hour intervals. Every two weeks, controlling measurements of ammonia concentration were made with Kitagawa gas detector tubes 105SD (Mikrolab, Aarhus, Denmark).

Results and Discussion

Ammonia

In table 1, the average ammonia concentration in the air stream before and after the filters in the two filter rooms is shown. The ammonia concentration was significantly reduced in the filters ($P<0.05$). The ammonia concentration in the air stream before the filters ranged between 8.1 and 9.0 ppm during the winter period and between 4.1 and 5.9 ppm during the summer period. The ammonia concentration in the air stream after the filters was in the range of 1.2 to 2.4 during the entire study. Thus, it seems that the filters were able to reduce the ammonia concentration in the outlet air to approximately the same level despite the variations in the ammonia concentration in the air stream before the filters.

Table 1. Average ammonia concentration (ppm) in the air stream before and after a commercial biotrickling filter (SKOV A/S, Glyngøre, Denmark) in a unit with growing-finishing pigs. 95 % confidence limits are placed in brackets.

| Batch | Period | Filter room 1 | | Filter room 2 | |
|-------|---------------|--------------------|--------------------|--------------------|--------------------|
| | | Before | After | Before | After |
| 1 | 14.10 - 13.12 | 9.0 (8.7 – 9.4) | 1.2 (0.8 – 1.6) | 8.2 (7.7 – 8.6) | 1.3 (0.9 – 1.7) |
| 2 | 07.01 - 22.03 | 8.1 (7.8 – 8.4) | 1.8 (1.5 – 2.1) | 8.3 (8.0 – 8.6) | 1.6 (1.3 – 1.9) |
| 3 | 28.05 - 29.06 | 4.1 (3.6 – 4.5) | 2.2 (1.7 – 2.7) | 5.9 (5.4 – 6.4) | 2.4 (1.9 – 2.9) |
| 4* | 10.08 - 22.10 | - | - | 4.3 (3.8 – 4.7) | 2.1 (1.6 – 2.5) |

* In period 4, the hoses between filter room 1 and the ammonia analyzer were leaking and therefore data are not shown for this period.

Odour

In figure 1, odour concentrations are shown for all pair wise measurements before and after the filter in filter room 1. The odour concentration was significantly reduced in the filter ($P<0.05$). The reduction in odour concentration averaged 54 % during the winter period (95 % confidence limits: 45-63) and 28 % during the summer period (95 % confidence limits: 17-39). A possible explanation for the lower odour removal efficiency during the summer period was a reduced retention time in the filter due to the increased ventilation rate. A reduced retention time reduces the contact between the biofilm and the outlet air and thereby the odour removal. It was also observed that some areas on the cellulose pads were clogged up with dust and biofilm. The clogging with dust and biofilm may also have impaired the odour removal.

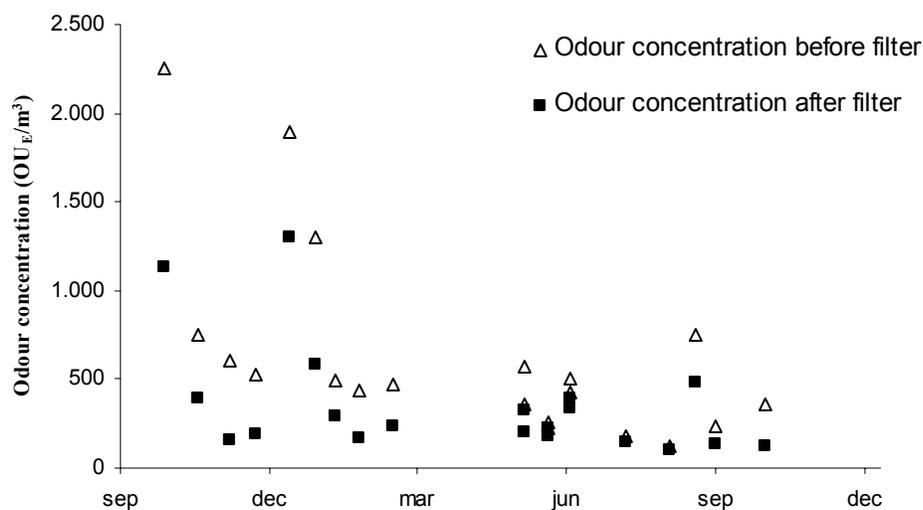


Figure 1. Odour concentration (OU_E/m³) in the air stream before and after a commercial biotrickling filter (SKOV A/S, Glyngøre, Denmark) in a unit with growing-finishing pigs.

Conclusions

In conclusion, the biotrickling filter was able to reduce the ammonia concentration in the outlet air from a unit with growing-finishing pigs to approximately 1.2 to 2.4 ppm. The filter was able to reduce the odour concentration in the outlet air although the odour removal efficiency was higher in the winter period (54 %) compared with the summer period (28 %). The investigation demonstrated that it is required to improve the odour removal efficiency during the summer and to find methods to increase the retention time of the air in the filter and prevent the clogging of the filter with dust and biofilm.

References

- CEN. 2003. Air Quality - Determination of odour concentration by dynamic olfactometry (EN13725). Brussels, Belgium: European Committee for Standardization.
- Melse, R.W. and N.W.M. Ogink. 2005. Air scrubbing techniques for ammonia and odour reduction at livestock operations: Review of on-farm research in the Netherlands. *Transactions of the ASAE* 48(6): 2303-2313.