Med. Fac. Landbouww. Rijksuniv. Gent, 56(4a), 1991

BIOLOGICAL PURIFICATION OF WASTE GASES FROM WASTE WATER TREATMENT PLANTS

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ABSTRACT

Butanal was chosen as a model compound for testing the performance of biofilters. It's a member of an important class of odour compounds released by waste water treatment plants of animal rendering and food processing industry.
The influence of nutrient supplementation has been investigated using two identical wood bark biofilters. These biofilters were loaded with a synthetic waste gas, containing about 10 ppm (v/v) of butanal. On the first biofilter (biofilter 1) a nutrient solution was supplied. The second biofilter (biofilter 2) was operating without nutrient solution.
During 12 weeks the biofilters were loaded with butanal at a volumetric load of 100 m^3/m^2 h. During this period a more regular removal and a larger mean elimination efficiency was obtained for biofilter 1 (97 %) than for biofilter 2 (86 %). Different loads were applied to evaluate the elimination capacity. An elimination capacity of 90.4 g/m^3 h was reached with nutrient supplementation. In absence of this supply the maximum elimination capacity was 74.5 g/m^3 h.

1. INTRODUCTION

In recent years biotechnological methods have increasingly been applied in the controlled processing of different kinds of wastes. With respect to the purification of polluted air, biofiltration can be concidered by now to be a technique which is frequently applied for the odour abatement (1). This technique is based on the ability of microorganisms to degrade organic/inorganic pollutants to water, carbon dioxide and mineral salts. In a biofilter the odorous air is directed through a packed bed of materials, in which a suitable microbial population develops in course of time. The odour compounds and oxygen present in the odorous air are transferred into the biofilm (surrounding the packing material), where the microbial degradation takes place.

2. METHODS AND MATERIALS

A scheme of the experimental set up of the lab scale biofilter is given in figure 1. The biofilter was built up with three Plexiglass columns with a diameter of 0.10 m and a height of 0.33 m. Each column was filled with wood bark as packing material. The three columns were connected with each other to form a filterbed of 0.99 m height. Before entering the filter, the air passed through a wash flask and bubble column which

served as humidifier. Detailed characteristics of this material are given elsewhere (2). Flow rates were measured with an anemometer. The moisture content of the filter material was measured by difference in weight between samples before and after drying at 110 °C. Butanal concentrations were measured according to Sawicki *et al.* (3).
The GC-MS-analyses were performed by a Perkin-Elmer Mass Spectrometer with an automatic thermal desorption system. Air samples were adsorbed on Tenax GC Tubes.

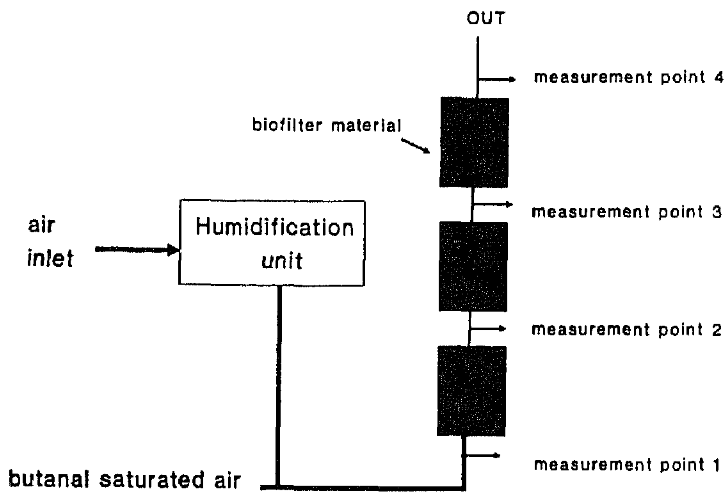


Fig. 1. Experimental set up of the lab scale biofilter.

3. RESULTS AND DISCUSSION

Aldehydes are an important class of odour compounds released by waste water treatment plants of animal rendering and food processing industry. This can be inferred from fig. 2. Figure 2 shows a GC-MS-chromatogram of the air emitted by a waste water treatment plant of the animal rendering industry. The aldehydes presented in the waste gas are also indicated. These aldehydes are formed by the oxydation of fatty acids and the Strecker degradation of amino acids (4). Butanal was chosen as a model aldehyde for testing the performance of biofilters. Butanal has a low odour treshold of about 13 $\mu g/m^3$, according to Gemert and Nettenbreyer (5).
The influence of nutrient supplementation has been investigated using two identical biofilters with wood bark as packing material. The nutrient solution contained following substances : Na_2HPO_4 0.8 g/l; NaH_2PO_4 0.2 g/l; $CaSO_4 . 2 H_2O$ 0.05 g/l; $MgSO_4 .7H_2O$ 0.5 g/l; $(NH_4)_2SO_4$ 1.0 g/l and $FeSO_4 . 7 H_2O$ 0.01 g/l. On the first biofilter (biofilter 1) 14 days daily, later weekly 30 ml of the nutrient solution was supplied. The second biofilter (biofilter 2) was operating without nutrient solution. These biofilters (filter bed height of 0.99 m, pH 6.5 and a moisture content of 57 %) were loaded with a synthetic waste gas, containing about 10 ppm (v/v) of butanal. During twelve weeks the biofilters were loaded with the aldehyde at a volumetric load of 100 m^3/m^2 h. During this period

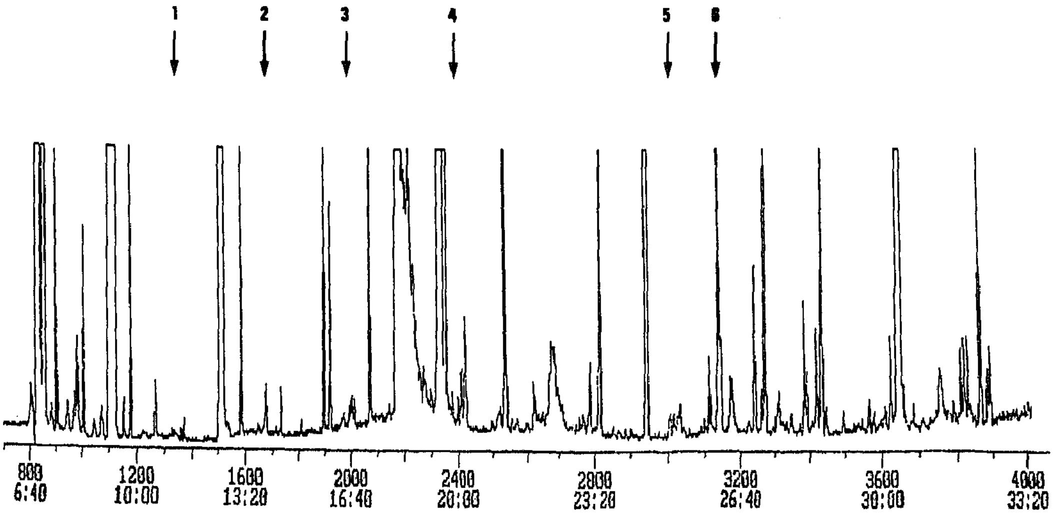


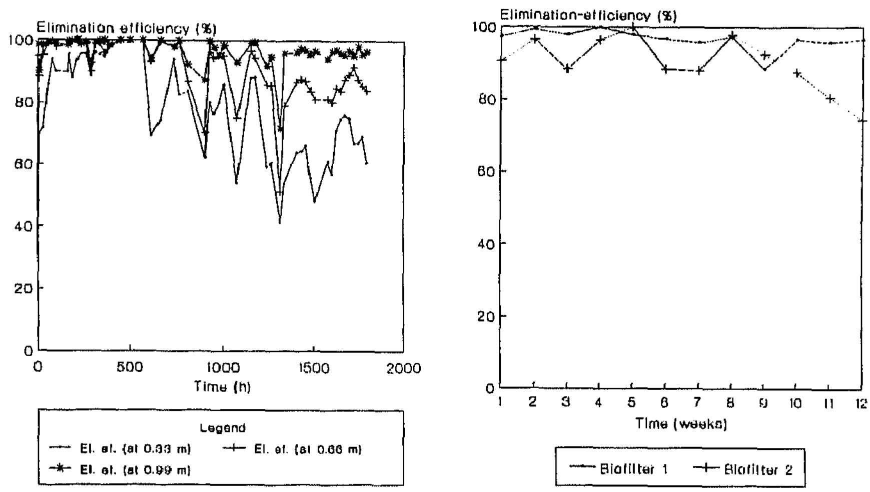
Fig. 2. Chromatogram of the GC-MS analysis of organic volatiles emitted by a waste water treatment plant of the animal rendering industry. Founded aldehydes are : 1. heptanal, 2. octanal, 3. 2-isononenal, 4. 2,4-nonadienal, 5. 2-decenal and 6. decanal.

the butanal concentrations were measured at four heights (0.00 m, 0.33 m, 0.66 m, 0.99 m). The results are expressed as the elimination efficiency, calculated as follows :

$$\eta = (1 - Ci/Co) \times 100 \ (\%)$$

with : η = the elimination efficiency (%);
Ci = the butanal concentration measured at height i in the biofilter;
Co = the butanal input concentration.

Results of the efficiency measurements for biofilter 1 are given in figure 3a. Figure 3b compares the elimination efficiency of both biofilters.



(a) (b)

Fig. 3. a. Elimination efficiency (η) for different filter bed heights as function of time (biofilter 1) - b. Comparison between both biofilters.

The main objective of the investigations was the evaluation of nutrient supplementation. During twelve weeks a more regular and a larger mean elimination efficiency was obtained for biofilter 1 (97 %) than for biofilter 2 (86 %) (see fig. 3b).
Alternatively different butanal loads were applied to evaluate the elimination capacity. A typical curve for each biofilter was obtained (see figure 4a and 4b). At a critical load the so called maximum elimination capacity is reached. An elimination capacity of 90.4 g/m^3 h was reached with nutrient supplementation. In the absence of this supply the maximum elimination capacity was only 74.5 g/m^3 h.

4. CONCLUSIONS

Butanal was removed from odorous air in lab scale wood bark biofilters with a high elimination efficiency. A higher elimination efficiency and capacity was obtained in the case of nutrient supplementation. Possible reasons for this effect are a pH stabilisation and a better nutrient balance for the microorganisms.

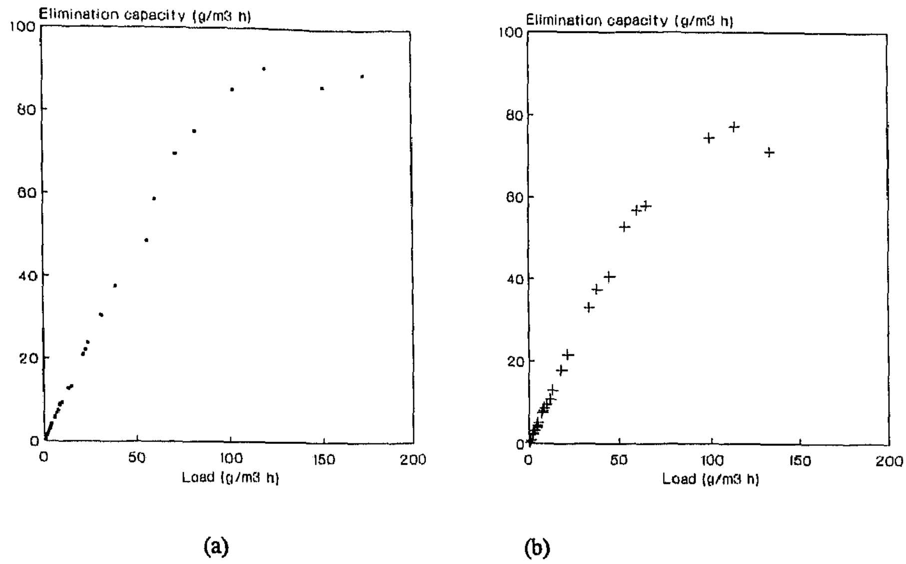


Fig. 4. Elimination capacity of biofilter 1 (a) and 2 (b) as function of the butanal load.

ACKNOWLEDGMENT

The authors thank G. Engelbosch and C. Creemers of the Laboratory of Physical Chemistry (Katholic University of Leuven, Belgium) for the GC-MS-analyses.

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