

## **Emission of fungal spores from a biofilter**

**- Short communication -**

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### **Abstract**

The biofilter of a compost plant was examined with regard to its influence on the fungal spore concentrations in the bioaerosol of the emitted air of the plant when passing the biofilter. In the cases studied the levels of *Aspergillus fumigatus* spores were reduced, but the spores of other fungi inhabiting the biofilter, especially *Paecilomyces variotii* and *Aureobasidium pullulans*, were released into the emitted air.

### **1. INTRODUCTION**

The release of microorganisms from waste treatment plants into the environment is causing increasing concern among the general public. Because of their high and sometimes multiple hazard potential for human health (allergies, toxicosis, infections), fungi are a focus of interest here. If the exhaust air from a waste treatment plant is conducted through a biofilter, the latter may itself become a source of germ emissions, because it contains average levels of  $10^5$  to  $10^8$  microorganisms per gram of biofilter dry substance.

On the other hand, a biofilter can bind particles by adsorption, which reduces the microorganism concentrations in the exhaust air stream.

In a study conducted for orientation purposes the aim was to examine the question as to whether a biofilter can lower the microorganism levels in the exhaust air from a compost plant or whether these levels rise: The indication of total numbers, e.g. of fungi, is of little help here, because fungal propagules can simultaneously be adsorbed in the biofilter and spores of fungi located in the filter can be emitted without substantially changing the total culturable number of fungus units. The spectrum of species may change, however. In the study therefore the numbers of individuals of the predominant species were determined in addition to the total numbers of fungi in the various media.

## **2. FACILITY AND METHODS**

### **Description of the facility**

The compost plant was exclusively used for the processing of biological waste. In order to improve rotting, the sieve overflow of the finished compost was added to the biological waste as a structural material. The exhaust air from the different rotting areas could be fed into the biofilter separately. The examinations presented here were based on the exhaust air collected from the biological waste composted over a period of 3 weeks.

The compost was ventilated with fresh air. The exhaust air was fed to the biofilter via a fan. The specific filter area load could be adjusted to a value between 159 and 18 m<sup>3</sup>/(m<sup>2</sup> x h).

The biofilter was a flat biofilter of container design. It was three months old at the time of the measurement. The bulk height of the biofilter material (bark scrap: pH 5.5, water content 71 %, bulk weight 0.57 Mg/m<sup>3</sup>, pore volume 43 %, grain size fraction > 4 mm > 80 %, water capacity 2.4 kg/kg dry matter) was 1.2 m on a root wood mattress with a thickness of 0.2 m.

### **Sampling and analysis**

The untreated air was sampled by isokinetic means from the exhaust air duct with sampling devices in accordance with VDI 2066, part 7. The location from which the samples were drawn was selected from the cross section of the air duct in such a way as to be representative of the average flow rate determined at 7 measuring points (VDI 2066, part 1). The biofilter exhaust air was sampled on the biofilter on two representative sampling fields sized 2m x 2m using a sampling hood in accordance with VDI 3881, also by isokinetic means, and in accordance with VDI 2066, part 7.

The samples were sucked for 15 minutes for each of the 8 replicates onto sterilised polycarbonate membrane filters (pore width 0.8 µm) in sterile filter holders. They were converted in each case into a 10 ml sterile sodium chloride (0.9 %)-Tween 20 (0.02 %) solution, brought into the laboratory under cool conditions (4 - 7 °C) and prepared there on the subsequent day. The samples were eluted using a vortex mixer (2 min.). Multi-stage dilution series were made and in each case 0.1 ml suspension was spread onto malt extract agar in three replicates. The mesophilic fungi were cultivated at 25 °C and the thermophilic fungi at 45 °C for 7 days.

The microorganisms of the biofilter material were eluted in that way: 100 g fresh matter were shaken together with 900 ml of the above given salt/Tween-solution in a rotatory shaker (30 min., 200 rpm). The subsequent treatment and analysis were the same ones as for the air filter samples.

### 3. RESULTS AND DISCUSSION

The most important results are shown in Figures 1 to 3. For the sake of greater clarity, the findings for the individual samples have been combined to form geometrical mean values. Furthermore, these figures only show those fungus species which, on the one hand, occurred in large quantities and, on the other, displayed even enrichment or reduction behaviour in the biofilter through all repeated operations.

The spore concentration of mesophilic fungi in the untreated air from the three weeks composted biological waste was relatively low (Fig. 1). Once it has passed through the biofilter, the spore concentration was lowered on geometrical mean by 17 %. This reduction was due mainly to *Aspergillus fumigatus*, whose spores were clearly strongly adsorbed by the biofilter material in all the individual measurements.

Other species of fungus displayed an indifferent behaviour - in some cases their spore concentration was higher in the untreated air and in some cases lower than in the biofilter exhaust air - while, for example, *Aureobasidium pullulans* only occurred in the biofilter exhaust air. This contrary behaviour became more evident in the samples cultivated at 45 °C (Fig. 2). *Aspergillus fumigatus* was reduced, while *Paecilomyces variotii* only arose in the biofilter exhaust air downstream of the biofilter. Further thermophilic species of fungus were also emitted in greater quantities from the biofilter, and so overall the spore concentration for thermophilic species was greater in the biofilter exhaust air than in the untreated air.

Figure 3 shows the high levels of *Paecilomyces* and *Aureobasidium* in the biofilter material, which points towards the source of high fungus levels in the biofilter exhaust air. It is surprising that, in the case of *Aspergillus fumigatus*, there was hardly any release despite high levels in the biofilter; only a strong sorption of this fungus from the untreated air can be seen from all the samples taken.

The considerable reduction of *Aspergillus fumigatus* levels in the exhaust air from a compost plant using a biofilter should be regarded as a positive factor with regard to hygiene, because this fungus is especially pathogenic vis-à-vis humans. The release of *Paecilomyces variotii* from the biofilter partly counteracted this positive effect, because this species can cause allergic alveolitis and may be a source of humidifier fever.

Taking into consideration different volumetric flows and emission rates from the various rotting areas, as well as the initial load of the feed air, the following emission rate was estimated for the biofilter (480 m<sup>2</sup> surface) as a whole (CFU/h): mesophilic fungi:  $2.1 \times 10^8$ ; thermophilic fungi:  $1.6 \times 10^8$ ; *Aspergillus fumigatus*:  $1.9 \times 10^7$ . The resulting concentrations in the surrounding area were estimated using model calculations.

The presented results yielded only at the combination of one compost plant and one biofilter type may not be regarded as representative of the effects of each biofilter on the fungal flora in the exhaust air of any compost plant. In this field further research is needed.