Odour and H_2S degradation in a full scale biofilter with a mineral based organic coated filter media

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ABSTRACT

In order to minimize the odorous emissions from sludge storage tanks on the waste water treatment plant «Niederrad» of the city of Frankfurt/Main, about 12.000 m^3/h of foul air has to be treated.

Due to high Hydrogen-Sulphide (H_2S) loads, the installed standard biofilter systems failed operation after one year. Thus, one of the existing filter beds was filled with a mineral based organic coated material; the other one was re-filled at the same time with a standard biofilter media to allow a comparative study. In a long term monitoring program from May 2006 to June 2007, both media were compared regarding degradation of H_2S and odour. The one-year measurement program revealed that the mineral high performance media performs much better then the standard organic media.

1 INTRODUCTION

In order to minimize the odorous emissions from sludge storage tanks on the wastewater treatment plant «Niederrad» of the city of Frankfurt/Main, about 12.000 m^3/h of foul air has to be treated. A first step was the installation of a biofilter with a humidifier, designed in 2004 according to estimated loads. Shortly after start-up of the biofilter operation, severe odorous emissions from the biofilter were recognized. In 2005, a first filter monitoring campaign, performed by the operator, showed that the H_2S concentration in the raw gas was much higher than estimated during design and was

also much higher than recommended in the VDI guideline 3477 (2004) for biofilter design.

As a replacement of the biofilter with a chemical scrubber would have caused serious problems in terms of space restrictions and economic aspects, the first choice was to undertake a test with a new, high performance biofilter media, which, according to the manufacturer, would be able to deal with high H_2S loads. This so called IHCS (inert hydrophilic compound structure) media was filled in one of the two existing filter beds in spring 2006; the other one was re-filled at the same time with a standard biofilter media to allow a comparative study.

In a long term monitoring program from May 2006 to June 2007, performed by the University of Kassel, both media were compared regarding degradation of odour and H_2S.

2 MATERIALS AND METHODS

2.1 Treatment plant layout

The technical specifications of the air treatments system is given in Table 1.

Table 1.
Technical specification of air treatment.

Aspect	Unit	line 1	line 2
Air stream	m^3/h	6.000	6.000
Filter size	m^2	85	85
Filter volume	m^3	150	150
Filter media	-	Mineral based organic coated IHCS media by Otto Industries, Bad Berleburg (D)	Wood mix (root wood, chipped wood and bark mulch)

The IHCS media was developed by Otto Industries, Bad Berleburg (D), and it was the first time that its performance was comparatively tested in a large scale application on a wastewater treatment plant.

The core of the IHCS media consists of clay granulate and the coating is a mixture of cement, fertilizer, activated carbon and chipped wood (OTTO, 2005a). The material could be recycled by the producer (OTTO, 2005b).

Figure 1. shows a sketch of the installed air treatment system.

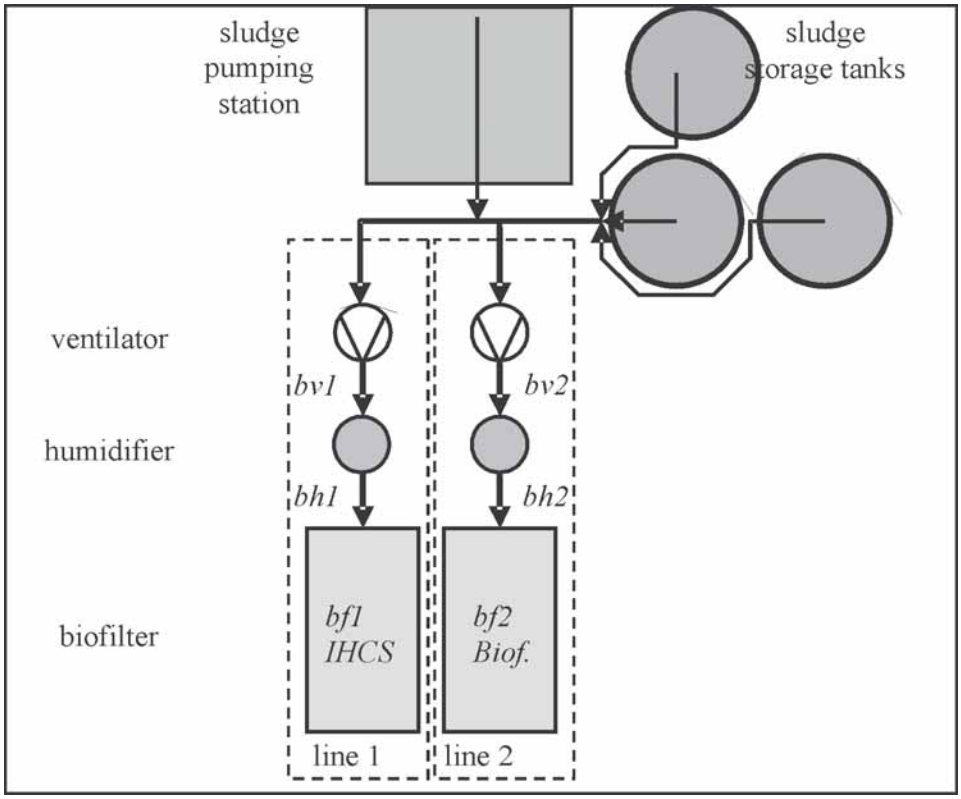

Figure 1. Scheme of the air treatment system with sampling points.

All sampling points (behind ventilator line 1 [bv1], behind humidifier line 1 [bh1], behind filter line 1 [bf1], bv2, bh2 and bf2) are marked in the scheme. For comparison of the filter performance, this paper focuses on sampling points bh1, bh2, bf1 and bf2.

2.2 Odour measurement

The quantification of odour is the key to describe the odorous performance of an air treatment system. In order to fulfil European standards, the odour concentration was measured according to DIN EN 13725:2003, updated with DIN EN 13725:2006.

The basis of this measurement method is that odour could be recognized by a person if the individual odour threshold is exceeded. For example, if an odorous air needs to be diluted 2n times for just not exceeding and n times for exceeding the odour threshold, the odour concentration is the geometric mean of n and 2n, which is 1.41n. For improving statistical accuracy on the whole, twelve or more single

measurement results are needed to calculate the dilution number. Although a dilution number has no unit, the odour concentration c_{od} is denoted with European odour units per cubic meter (ou_E/m^3).

2.3 H_2S-Measurement

H_2S-Measurement was performed with Odalog measurement devices by AppTek (AUS). An OdaLog detects H_2S-concentrations from 0 ppm to 200 ppm with a resolution of 0,1 ppm. A data logger is included, which can store 32.000 sets of values (date/time, concentration of H_2S and temperature). The device has an IR-connector for periodical data acquisition and optionally (OdaTrak) a fibre optics connector for online data transfer.

3 RESULTS AND DISCUSSION

3.1 Odour measurement

The result of the odour measurement program is shown in Figure 2.

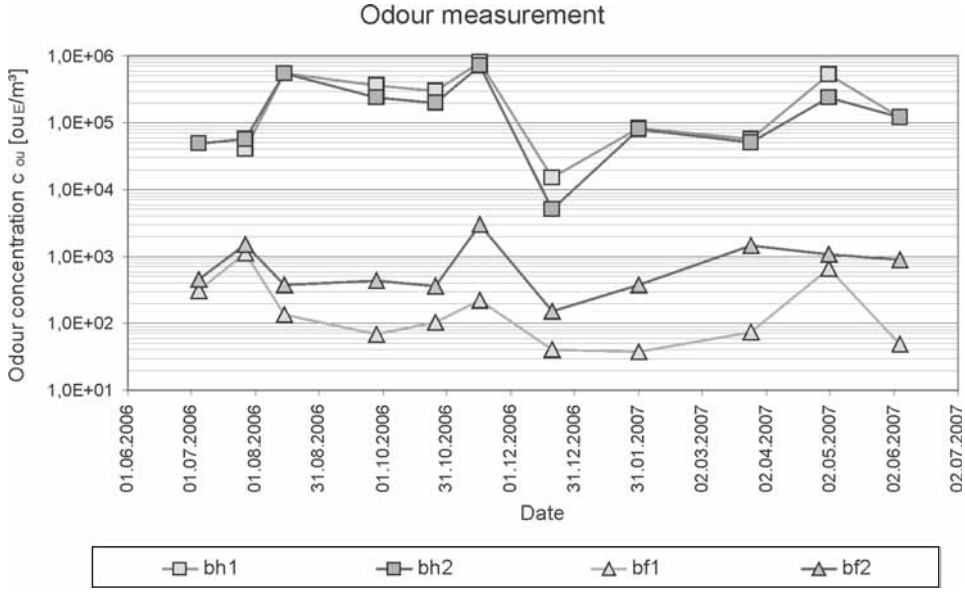

Figure 2. Results of the odour measurement program.

On the whole, eleven samples were taken and analysed during one year. The IHCS-filter (bf1) always showed a higher efficiency and most of the time reached

significant lower clean gas concentrations than the standard woodmix biofilter (bf2). The difference between the two materials tended to become bigger near the end of the measurement campaign.

The deviation in concentration values in raw gas between both air treatment lines was caused by the disadvantageous connection of the pumping station exhaust air outlet behind the air splitter into line 1 pipe (Figure 1) that made this highly polluted air stream move only into line 1 and not into line 2.

3.2 H_2S Measurement

The online monitoring delivered 350,000 to 430,000 sets of values for each sampling point during one year. The difference was caused by availability of devices and some necessary service stops.

In Figure 3, the frequencies of the H_2S-concentrations is presented. The raw gas concentration of H_2S showed an average value of 25.7 ppm for the IHCS filter (bh1) and 23.9 ppm for the wood mix biofilter (bh2). It can be seen clearly that H_2S degradation was performed successfully in both filter units, as H_2S values of less than 1 ppm were detected in the clean gas.

The effect of connecting the pumping station exhaust air to the pipe system behind the air splitter can be seen clearly. Only line 1 employing the IHCS filter material is loaded with this highly polluted air.

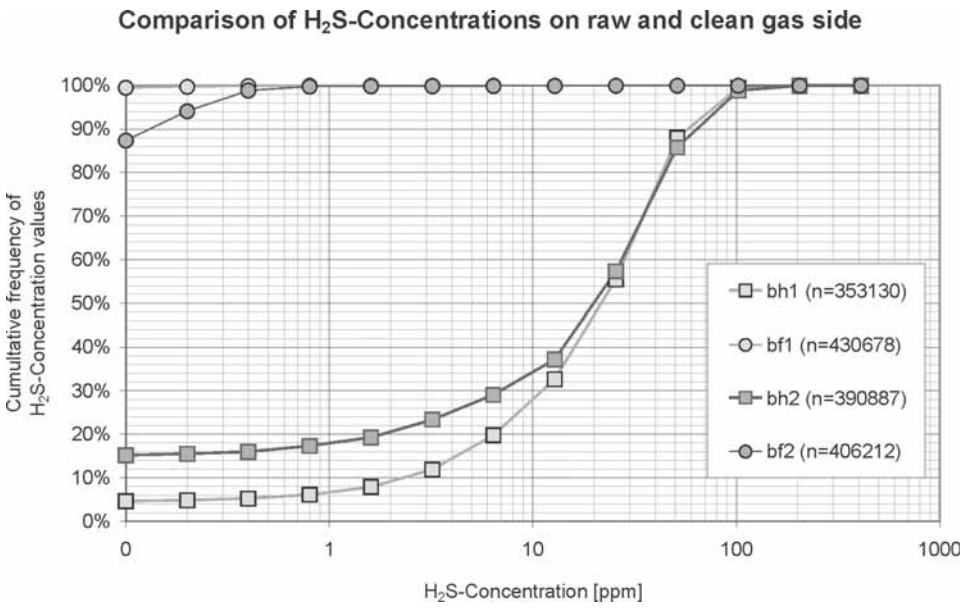

Figure 3. Results of H_2S-Monitoring.

An estimation of the total H_2S load for both filters can give an impression of the possible load capacities. Other sulphurous gases like thiols or dimethyl sulfide (DMS) were disregarded as well as the sulphur runoff from the two biofilter line effluents that will definitively contain sulphuric acid; because no data were available on this streams.

Keeping this in mind, the estimated H_2S loads are 1,919 kg H_2S/a for the IHCS filter and – slightly less – 1,786 kg H_2S/a for the wood mix biofilter (6,000 m^3/h, mean values of H_2S concentrations). With regard to filter volumes of 150 m^3, the specific H_2S load capacity of the IHCS was 12.8 kg/m^3 without filter breakdown and for the standard wood mix biofilter 11.9 kg/m^3 with operation failure in the end.

4 CONCLUSIONS

Both air treatment systems operated successfully during most of the time. Although the IHCS filter was loaded with more H_2S and odour than the standard filter, it was more advantageous concerning degradation performance, even increasing towards the end of the one year operation.

Hence, the mineral based organic coated biofilter media seems to be an interesting way of improving standard biofilters. This material allows operation of biofilters with average H_2S concentrations of 20 ppm, which is much higher than VDI guideline 3477 (2004) recommends.

Economic aspects depend on the alternatives. The IHCS media is more expensive (specific material cost 270 €/m^3) than a standard biofilter media (specific material cost 60 €/m^3). In this case the upgrade of the biofilter with the new IHCS media was more economic than the installation of a chemical scrubber regarding investment as well as annual cost.

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