H_2S and Odor Control at Wastewater Collection Systems: An Onsite Study on the Robustness of a Biological Treatment

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Introduction

Cities are searching for cost efficient and community friendly methods of dealing with odors emitted from wastewater collection systems. Traditionally, odor control methods involved chemical addition to the collection system. While fairly effective, in most cases chemical addition is very costly, can give operational and maintenance concerns, and can be intrusive to the local community.

Biological treatment systems offer an attractive alternative to chemical addition odor control. Due to recent developments, biological techniques also overcome a lot of drawbacks and disadvantages associated with classical, physical-chemical air purification techniques like chemical scrubbers or activated carbon filters.

An often heard concern about biological air treatment systems is the unknown aspects of it's robustness to fluctuations, upsets and operational failures. This poster quantifies this concern.

Objectives

A full-scale multi-layer biological air treatment system (the Purspring bioreactor^{TM}, which is described elsewhere by Kraakman, 2001) was tested at the Hyperion WWTP in Los Angeles for performances and robustness. Results about this onsite study have been described elsewhere (Kraakman et al., 2003 and Gilano et al., 2004). This poster shows the results of experiments executed to quantify the robustness of this biological system during normal operation.

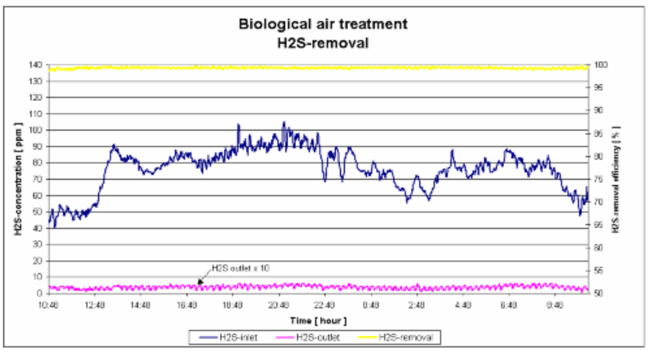
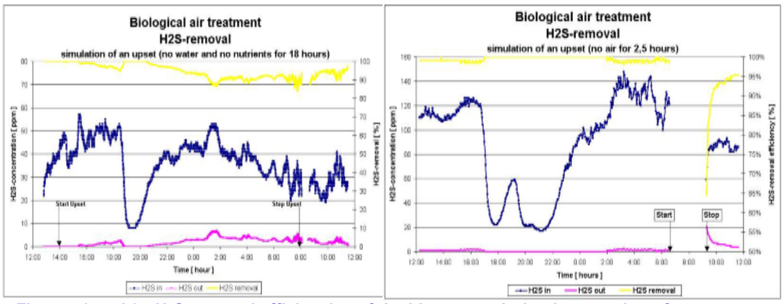


Figure 1: H_2S-removal during normal operation at typical daily inlet fluctuation.



Figures 2 and 3 : H_2S-removal efficiencies of the bioreactor during interruption of water and nutrient supply (simulating water and nutrient supply failures) and during interruption of the air supply (simulating a failure of the fan) and it's recovery.

Results

Figure 1 shows the removal of H_2S during normal operation. The removal during two out of the many upsets tested are shown in Figure 2 and 3. The absence of water and nutrient supply results in a declining removal efficiency from 99 to 85% over a period of 18 hours (Figure 2). The absence of the inlet air supply for a period of 2,5 hours resulted, after the air supply was restored, in an initial removal of 65% to 95% in 1 hour (Figure 3). Full recovery after all upsets tested took place within 24 hours. Table 1 shows the risk analysis of all the upsets that can be encountered at this location.

Table 1: Risk analyses of the different upsets that is estimated to occur at this location.

Upset		p	E	R	
		probability	negative effect	risk	
BIOLOGICAL UPSET	OPERATIONAL UPSET	*occasions per year*	*loss of removal efficiency*	*% loss (of the total load removed per year)*	*Number of occasions removal eff. < 80%*
No water	water valve fails (24 hours)	2	99→85% in 24 h 85→99% in 12 h	0,058	
	water supply fails (8 hours)	1	99→95% in 24 h 95→99% in 12 h	0,008	
No energy source	fan fails (1 day)	1	65→90% in 1 h 90→99% in 22 h	0,015	1
Fluctuations of energy source	fluctuating inlet concentrations out of acceptable range	0	n.d.	0	
No nutrients	nutrient pump fails (1 day)	1	99→90% in 24 h 90→ 99% in 12 h	0,019	
	storage tank empty (1 day)	4	99→90% in 24 h 90→ 99% in 12 h	0,056	
Out of temperature range	inlet air temperature too high	0	n.d.	0	
	inlet air temperature too low	0	n.d.	0	
No water, nutrients and energy source	no electricity (1 day)	2	65→90% in 1 h 90→99% in 22 h	0,030	1
TOTAL RISK				0,19	2

Definition of Robustness:
Robustness of the biological system is here defined as the ability to deal with fluctuations and ability to recover after an upset.

The risk of negative effects on a biological system (R) can be defined as:

$$R = p \times E$$

p = the probability on occurrences of an upset
E = the negative effect of the upset

Knowing the robustness would be of help to engineers and operators to design the right installation and to define effective operation procedures in order to minimize the risks for sub-optimal biological air purification.

Conclusions

Robustness of a biological air purification system was tested and quantified for different situations, showing slow decrease of efficiencies and relatively fast recovery after realistic upsets.

Literature: Kraakman, N.J.R. (2001) New bioreactor system for treating suphur- or nitrogen-compounds. In: Bioreactors for waste gas treatment: Kluwer Acadamic Publicers, Edited by Kennes, C., Veiga., M.C.
Gilano, C.A., Haug, R.T., Wojslaw, J.A., Van Durme, G.P. (2004) Los Angeles selects bio-trickling/activated carbon for collection system odor control. In: Proceedings of USC-TRG Conference on Biofiltration, Los Angelos, October 2004
Kraakman, N.J.R. (2004) H_2S and Odour Control at Wastewater Collection Systems: An Onsite Study of Biological Treatment. In: Proceedings of Enviro Conference, Sydney April 2004.

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