Bioresource Technology 123 (2012) 548–557

Contents lists available at SciVerse ScienceDirect

Bioresource Technology

journal homepage: www.elsevier.com/locate/biortech

Resistance and resilience of removal efficiency and bacterial community structure of gas biofilters exposed to repeated shock loads

Léa Cabrol [a,b,*], Luc Malhautier [a], Franck Poly [c], Xavier Le Roux [c], Anne-Sophie Lepeuple [b], Jean-Louis Fanlo [a]

[a] Laboratoire Génie de l'Environnement Industriel, Ecole des Mines d'Alès, Rue Jules Renard, 30100 Alès, France
[b] Veolia Environnement Recherche et Innovation, Chemin de la Digue, BP76, 78600 Maisons Laffitte, France
[c] Laboratoire d'Ecologie Microbienne, Université de Lyon, Université Lyon 1, CNRS, INRA, UMR CNRS 5557, USC INRA 1193, Bâtiment Gregor Mendel, 43, Boulevard du 11 Novembre 1918, 69622, Villeurbanne Cedex, France

HIGHLIGHTS

- Four biofilters were exposed to repeated substrate pulses of increasing intensity.
- New quantitative indices of resistance and resilience capacity were proposed.
- We highlighted different robustness levels according to the contaminants.
- There was an impact of the perturbation regime at the community level (DGGE).
- Bacterial community structure partially coupled to removal efficiency robustness.

ARTICLE INFO

Article history:
Received 28 May 2012
Received in revised form 9 July 2012
Accepted 11 July 2012
Available online 20 July 2012

Keywords:
Biofiltration
Resistance
Resilience
Community structure
DGGE

ABSTRACT

Since full-scale biofilters are often operated under fluctuating conditions, it is critical to understand their response to transient states. Four pilot-scale biofilters treating a composting gas mixture and undergoing repeated substrate pulses of increasing intensity were studied. A systematic approach was proposed to quantify the resistance and resilience capacity of their removal efficiency, which enabled to distinguish between recalcitrant (ammonia, DMDS, ketones) and easily degradable (esters and aldehyde) compounds. The threshold of disturbing shock intensity and the influence of disturbance history depended on the contaminant considered. The spatial and temporal distribution of the bacterial community structure in response to the perturbation regime was analysed by Denaturing Gradient Gel Electrophoresis (DGGE). Even if the substrate-pulses acted as a driving force for some community characteristics (community stratification), the structure-function relationships were trickier to evidence: the distributions of resistance and composition were only partially coupled, with contradictory results depending on the contaminant considered.

1. Introduction

As a result of fluctuating industrial activity, full-scale biofilters are often submitted to unstable influent composition, concentrations and flow rates, which can alter the bioprocess in terms of both functional performance and community structure (Kraakman, 2003), especially when applied to the treatment of sludge composting emissions. It is thus of prime importance to identify the changing conditions that can alter the biofiltration, and to determine to what extent biofilters are able to cope with disturbance and to recover after disturbance.

Among other temporal variations, substrate pulses are ephemeral events of resource superabundance which are often observed in industrial biofilters. They induce microbial responses in terms of growth, decay or enzymatic activity and likely lead to shifts in microbial community structure (Chesson et al., 2004). However, whether the responses of the biological component to resource pulses reflect adaptive behaviours (genotype selection) and/or physiological effects is still unclear (Yang et al., 2008), which restricts the optimal management and operation of biofilters. In addition, as they can be controlled and monitored, lab-scale biofilters are model engineered ecosys-

* Corresponding author at: Laboratoire Génie de l'Environnement Industriel, Ecole des Mines d'Alès, Rue Jules Renard, 30100 Alès, France. Tel.: +56 32 2274178.
E-mail address: lea.cabrol@gmail.com (L. Cabrol).

0960-8524/$ - see front matter © 2012 Elsevier Ltd. All rights reserved.
http://dx.doi.org/10.1016/j.biortech.2012.07.033