Bioresource Technology 117 (2012) 300–309

Contents lists available at SciVerse ScienceDirect

Bioresource Technology

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

A modified dynamic respiration test to assess compost stability: Effect of sample size and air flowrate

Dimitrios Komilis *, Dimitrios Kanellos

Laboratory of Solid and Hazardous Waste Management, Department of Environmental Engineering, Democritus University of Thrace, Xanthi 671 00, Greece

HIGHLIGHTS

- We measured compost dynamic respiration indexes under different unit air flowrates.
- The unit air flowrates (UAF) ranged from 6 to 30 L air kg^{-1} VS h^{-1}.
- The dynamic respiration index (DRI) increased as the UAF increased.
- A negative correlation existed between the CO_2 index and the UAF.
- The respiratory quotients (RQ) decreased from 0.5 to 0.05 as UAF increased.

ARTICLE INFO

Article history:
Received 7 March 2012
Received in revised form 24 April 2012
Accepted 25 April 2012
Available online 2 May 2012

Keywords:
Compost stability
Dynamic respiration index
Air flowrate
Microbial respiration activity

ABSTRACT

Goal of this work was to study the effect of the unit air flowrate on dynamic respiration activity indexes during the assessment of compost stability. A MSW compost was used and six experimental runs were performed with variable compost masses and variable air flowrates, so that to achieve six unit air flowrates (6, 9, 16, 17, 23 and 30 L air kg^{-1} organic matter h^{-1}). Six respiration activity indexes were quantified, namely a dynamic respiration index (DRI_{24}), the cumulative O_2 consumption at 4 and 7 days ($DCRI_4$, $DCRI_7$), a CO_2 index, the cumulative CO_2 generation after 7 days (Total CO_2) and the respiratory quotient. Results indicate that the CO_2 related indexes and the respiratory quotients had a strong negative correlation with the unit air flowrate, whilst the DRI_{24} and both DCRIs slightly increased with increasing unit air flowrates.

1. Introduction

The composting process has the primary goal to produce a stabilized end-product. The term "stability" is related to the microbial decomposition or the microbial respiration activity of the composted matter (Iannotti et al., 1993). There has been quite a significant effort among researchers to characterize stable composts using indexes that are mainly based on the quantification of microbial respiration activity. The most common microbial respiration activity indexes are the ones based on oxygen consumption (or uptake) and carbon dioxide generation (or evolution). Respiration activity tests are classified in two major groups, namely the static and dynamic ones. The static respiration tests (SRT) are performed at the absence of a continuous air flow; O_2 consumption is often measured via pressure differences or via direct measurements of the O_2 content usually in the gaseous phase (Adani et al., 2001, 2003, 2006; Binner and Zach, 1999; Gea et al., 2004; Iannotti et al., 1993; Komilis and Tziouvaras, 2009; Komilis et al., 2011a; Ponsá et al., 2009, 2010a,b; Ruggieri et al., 2008; Wagland et al., 2009). On the other hand, dynamic respiration tests (DRT) are using a continuous air flow regime with the goal to achieve an adequate oxygen supply to the microorganisms. These dynamic tests require the precise measurement of air flowrate throughout the process and the measurement of the O_2 and CO_2 contents at the inlet and outlet of the test devices (Adani et al., 2006; Barrena-Gómez et al., 2005, 2006; Barrena et al., 2009; Gea et al., 2004; Ponsá et al., 2010a,b; Scaglia et al., 2000; Tremier et al., 2005; Wagland et al., 2009).

There is a large variability in the sample sizes and the air flowrates adopted during DRT. Sample sizes vary from 100 g (Ponsá et al., 2009, 2010a,b), to 500 g (ASTM, 1996) to up to 10–13 kg (Adani et al., 2001, 2003, 2006; CEN, 2007; Scaglia et al., 2000). Air flowrates also seem to vary during DRT. Ponsá et al. (2010a,b) have used an initial air flowrate of 30 and 20 ml min^{-1} for active and more stable samples, respectively to maintain O_2 content at the exhaust gases above 10% (v/v). The ASTM method suggests that the unit air flowrate (UAF) should not exceed 200 L kg^{-1} waste d^{-1}

* Corresponding author. Tel./fax: +30 2541079391.
E-mail address: dkomilis@env.duth.gr (D. Komilis).

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http://dx.doi.org/10.1016/j.biortech.2012.04.095