Bioresource Technology 119 (2012) 105–113

Contents lists available at SciVerse ScienceDirect

Bioresource Technology

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

Enhancement in mesophilic aerobic digestion of waste activated sludge by chemically assisted thermal pretreatment method

Vinay Kumar Tyagi, Shang-Lien Lo *

Graduate Institute of Environmental Engineering, National Taiwan University, Taipei 106, Taiwan, ROC

HIGHLIGHTS

- MW-alkali method (pH 12–95 °C) synergistically attained 52.5% COD solubilization.
- 54% VSS solubilization was observed.
- 81.1% TCOD and 72.4% VSS reductions was achieved after mesophilic aerobic digestion.
- 44% improvement in sludge filterability after aerobic digestion of pretreated sludge.
- Proposed method can produce sludge of good filterability & Class A quality.

ARTICLE INFO

Article history:
Received 9 April 2012
Received in revised form 23 May 2012
Accepted 25 May 2012
Available online 1 June 2012

Keywords:
Microwave-alkali pretreatment methods
Waste activated sludge
Sludge solubilization
Mesophilic aerobic digestion
Class A biosolids

ABSTRACT

The effects of hybrid microwave (MW)-alkali pretreatment methods on the efficiency of mesophilic aerobic digestion were studied. The MW-alkali pretreatment (95 °C-pH 12) was observed to enhance the sludge solubilization synergistically from 0.5% (raw) to 52.5% (MW-NaOH) and 48.7% (MW-KOH), which are 20% greater than the additive value of MW only and alkali only ($16\%_{MW} + 28.4\%_{NaOH} = 44.4\%$ and $16\%_{MW} + 25.5_{KOH} = 41.5$). The higher VSS solubilization was observed for hybrid MW-NaOH (53.9%) and MW-KOH (47.4%) methods. The batch mesophilic (35 °C) aerobic digestion system led to 81.1% TCOD degradation and 72.4% VSS degradation at 20 days of retention time, with 35% higher TCOD and VSS reduction in comparison with the control system. The filterability of microwave-alkali pretreated sludge was improved remarkably after aerobic digestion. Moreover, the proposed method is capable of effectively sanitize the sewage sludge and produce Class A biosolids.

1. Introduction

A continuous increase in the amount of sludge generation in municipal wastewater treatment plants (WWTPs) making anaerobic and aerobic digestion more essential as a stabilization process (Dogan and Sanin, 2009). However, slow and partial degradation of sludge, poor pathogen removal and longer retention time (20–30 days) are the major limitations of bio-digestion methods, which can overcome by disintegrating the sludge and making extracellular and intracellular material readily available to bio-digestion process (Guo et al. 2008; Tang et al., 2010). Several sludge disintegration techniques (Thermal, chemical and mechanical) and their combinations were studied before to enhance the sludge solubilization and improve the sludge dewaterability and pathogens destruction (Tyagi and Lo, 2011). Among the pre-treatment technologies studied, thermal disintegration at high temperatures (>100 °C) was found to be superior in terms of volatile solids (VS) reduction, biogas production and pathogens destruction. However, thermal treatment requires a huge demand of energy and longer contact time to achieve high temperature (Carrere et al., 2010). Thus, the emerging research has focused on the MW irradiation as a novel in the sludge line technique. The application of MW energy has the potential advantages over the conventional heating process because of its ability to heat rapidly, accelerating reaction rates, instant on/off control, ability to selectively heat substances, environment friendly, compactness and low overall cost (Remya and Lin, 2010; Tian et al., 2011). Generally, the sludge treatments with MW irradiation were studied at two temperature ranges (1) <100 °C and under normal pressure and (2) >100 °C and high-pressure requirement. Although the higher sludge solubilization are reported for high temperature and pressure treatment with MW irradiation (Eskicioglu et al., 2008, 2009)), nevertheless, the process will require higher capital, operational and maintenance cost and turn into an energy intensive technique. At this juncture, chemically assisted thermal pretreatment can offer an

* Corresponding author. Address: Graduate Institute of Environmental Engineering, National Taiwan University, No. 71, Chou-Shan Road, Taipei 106, Taiwan, ROC. Tel.: +886 2 2362 5373; fax: +886 2 2392 8821.
E-mail address: sllo@ntu.edu.tw (S.-L. Lo).

0960-8524/$ - see front matter © 2012 Elsevier Ltd. All rights reserved.
http://dx.doi.org/10.1016/j.biortech.2012.05.134