International Biodeterioration & Biodegradation 85 (2013) 631–637

Contents lists available at SciVerse ScienceDirect

International Biodeterioration & Biodegradation

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

Characterization of fresh leachate from a refuse transfer station under different seasons

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ARTICLE INFO

Article history:
Received 5 January 2013
Received in revised form
14 May 2013
Accepted 15 May 2013
Available online 5 June 2013

Keywords:
Fresh leachate
Characterization
Seasons
Three-dimensional excitation–emission matrix (EEM)
Bio-treatment

ABSTRACT

Fresh leachates in different seasons from a refuse transfer station in Shanghai were characterized and seasonal impact on physicochemical characteristics of the leachates was investigated. The leachate properties, including concentration of organic substances, nitrogen distribution, electric conductivity (EC), oxidation–reduction potential (ORP), etc. had been monitored in summer and winter. The results showed that pH, COD, TOC, TN and EC of the leachate in winter were much higher than those in summer. While other parameters, such as inorganic nitrogen, ORP, metals, TSS and VSS, showed no considerable distinction between the two seasons. Three-dimensional excitation–emission matrix (EEM) fluorescence spectroscopy was also conducted to characterize dissolved organic materials (DOM) of the leachate. The observation revealed that seasonal variations had direct effects on the fundamental characteristics of raw leachate, which provided useful potential reference for fresh leachate bio-treatment.

1. Introduction

Refuse transfer stations (RTSs), served as a link between the waste production nodes and waste treatment facilities or landfills via typical waste collection vehicles, are an important part during the modern municipal solid waste (MSW) management system (Chatzouridis and Komilis, 2012; Washburn, 2012). Within refuse transfer stations, the MSW is usually stored and compressed for following disposal, easily resulting in large amounts of fresh leachate especially generated by pressurizing of waste. For example, approximately 5–20% of the MSW were pressurized in Shanghai of China. The MSW leachate, a high strength wastewater always with complex and changeable composition, is characteristically rich in organic matters, ammonia, heavy metals, and other inorganic compounds, posing a significant threat to the surrounding environment and human health (Renou et al., 2008). Thus the effective treatment of the fresh leachte is becoming an urgent challenge, particularly in an economical and environment-friendly way. Novel wastewater treatment techniques, such as anaerobic digester (Kheradmand et al., 2010), up-flow anaerobic sludge blanket (UASB) reactor (Ye et al., 2011), expanded granular sludge bed (EGSB) reactor (Liu et al., 2010), etc., have been employed in recent years for the fresh leachate treatment.

With respect to above anaerobic processes, mediated by sequential fermentation reactions driven by microorganisms converting organic pollutants into simpler molecules (ultimately into CO_2 or CH_4) (Appels et al., 2008; Kawai et al., 2012), the properties of fresh leachate are considered as the critical role. The amount as well as constituent of organic substances in the leachate restricts the operation of bioreactors to a great extent. In addition, the leachate often contains components including high ammonium ion, heavy metals and salinity which inhibit the activity of anaerobic microbes. Simultaneously, the characterization of the MSW leachate exhibits considerable diversity under different seasons owing to variations in refuse composition, availability of moisture content, environmental temperature and precipitation, etc. (Tsarpali et al., 2012). All these parameters will affect physical, chemical and biological transformations within solid waste and apparently the properties of MSW leachate. Thus the seasonal variation of leachate quality is an important constraint for leachate biotreatment (Mangimbulude et al., 2009). Systematical characterization of leachate under

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http://dx.doi.org/10.1016/j.ibiod.2013.05.012

different seasons is significantly important to provide potential alternative for leachate management.

Recently, several studies have been conducted to understand impacts of seasonal alterations (such as rainfall regime, physico-chemical conditions at the dump) on the landfill leachate characteristics (Kawai et al., 2012; Rafizul and Alamgir, 2012; Tsarpali et al., 2012). However, there is hardly any effort dedicated to seasonal variations in the characteristics of the fresh leachate from RTSs, which possesses rather high strength compositions and is expected to be disposed by bio-processes first.

Therefore, the objectives of this study are to systematically characterize the fundamental properties of fresh leachate from a refuse transfer station and emphatically to investigate the seasonal impacts on leachate quality, to provide preliminary basis for treatment process option and operation of the fresh leachate.

2. Methods

2.1. Fresh leachate

The fresh leachate investigated in this paper was sampled from a refuse transfer station in Shanghai, China. The station has a daily transferring capacity of approximately 800 tons of MSW, which generates about 100 tons of leachate per day. The winter samples were collected from December 2011 to January 2012, and the summer samples were from June to July 2012. The collected samples were transferred to the laboratory within 2 h after sampling and then stored in a refrigerator at 4 °C to minimize biological and chemical changes.

2.2. Analytical methods

Leachate pH and redox potential were regularly performed by a pH meter (PHS-3C, Leici Co., China), while conductivity was measured using a conductivity meter (DDS-307, Leici Co., China). Chemical oxygen demand (COD), total suspended solids (TSS) and volatile suspended solids (VSS) were determined according to Standard Methods for Analysis of Waters and Wastewaters. Total organic carbon (TOC) and total nitrogen (TN) were systematically monitored using a TOC-VCPN analyzer (Shimadzu, Japan) with the combustion-infrared method, ammonia nitrogen (NH_3–N) by Nessler's reagent with the spectrophotometry method, nitrate nitrogen (NO_3^-) and nitrite nitrogen (NO_2^-) with ion chromatography method. Cations (Ca^{2+}, Mg^{2+}) were analyzed by ICP-AES (Optima 2100 DVICP-AES, PerkinElmer, USA).

Excitation–emission matrix (EEM) fluorescence spectra from leachate after 0.45 μm membrane filtrating and 100 times diluting were measured using a luminescence spectrometry (FluoroMax-4, Horiba Jobin Yvon Co., France) (Zhen et al., 2012). The leachate EEM spectra were gathered with the scanning emission (Em) spectra from 300 to 550 nm at 5 nm increments by varying the excitation (Ex) wavelength from 250 to 400 nm at 5 nm increments. Excitation and emission slits were both maintained at 5 nm, and the scanning speed was set at 4800 nm/min for all the measurements. The software Origin 8.0 (Origin Lab Inc., USA) was used to handle the original EEM data.

3. Results and discussion

3.1. Leachate pH

The pH changes of the leachate under different seasons are given in Fig. 1. It's obvious that fresh leachate from the RTS was acidic, with pH values ranging from 3.65 to 4.99 and 2.69 to 4.47 during winter and summer, respectively, similar to our previous findings (Liu et al., 2010). Overall, fresh leachate during summer depicted lower pH values as compared with that during winter. The lower pH of the leachate during summer was mainly due to more accumulation of volatile acids, attributed to the presence of dominant hydrolytic and acidogenic bacteria in the leachate (Sun et al., 2011). Comparable observation was also reported by Rafizul and Alamgir (2012), who indicated that higher temperature might bring out lower pH.

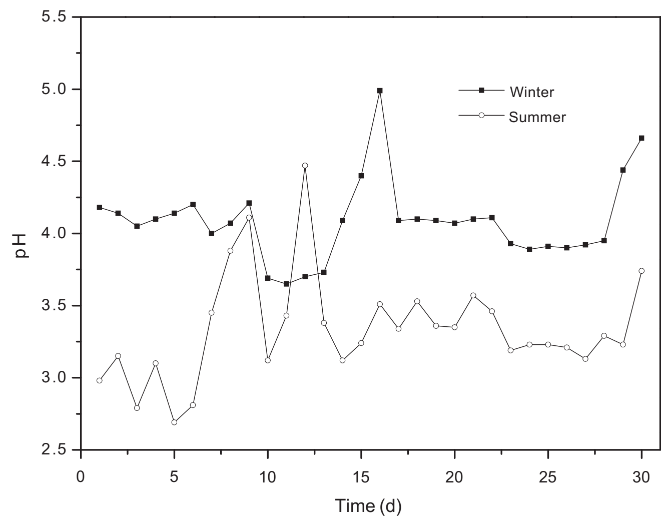

Fig. 1. Variations of leachate pH in different seasons.

3.2. COD and TOC concentrations

The amount of organic substances in the leachate, usually expressed with COD or TOC concentration, is one of the most considerable factors to affect its biodegradability. Fig. 2 illustrates the changes of COD and TOC concentrations of leachate during the studied period. The COD concentrations of the leachate in winter were undulated in the range of 32640–157200 mg/l. While during summer, the COD concentrations mainly ranged from 15000 to 92000 mg/l. The COD concentrations of the fresh leachate in summer were much lower than those in winter.

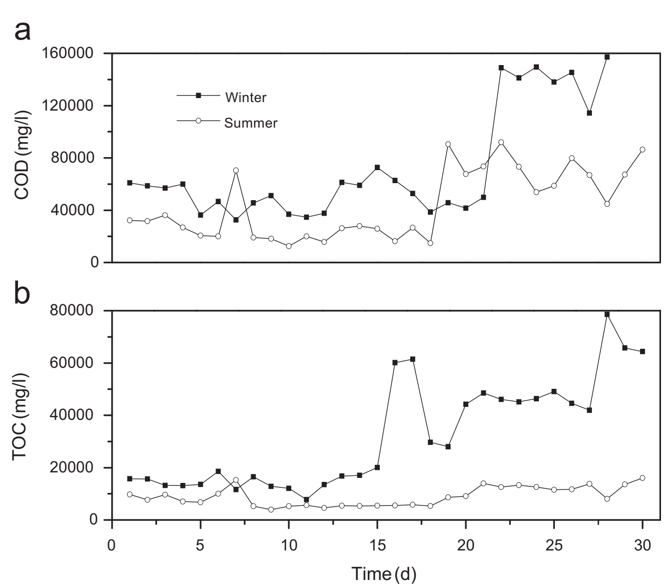

Fig. 2. Variations of COD and TOC concentrations in different seasons.