



# Temporal variation of trace compound emission on the working surface of a landfill in Beijing, China



Zhenhan Duan, Wenjing Lu\*, Dong Li, Hongtao Wang

School of Environment, Tsinghua University, Beijing 100084, China

## HIGHLIGHTS

- Temporal variations of trace components emission in a landfill were investigated.
- Highest concentrations appeared in summer; and most species were found in autumn.
- Oxygenated compounds were the most abundant compounds on the working surface.

## ARTICLE INFO

### Article history:

Received 30 July 2013

Received in revised form

18 November 2013

Accepted 25 January 2014

Available online 28 January 2014

### Keywords:

Trace components

Temporal variation

Landfill

## ABSTRACT

The temporal variation of trace component emissions from the working surface of a landfill in Beijing was investigated. Specific days in a year were selected as representatives for all four seasons. Different chemical species were quantified in all four seasons with the following average concentrations: spring: 41 compounds, 2482.6  $\mu\text{g m}^{-3}$ ; summer: 59 compounds, 4512.6  $\mu\text{g m}^{-3}$ ; fall: 66 compounds, 2438.4  $\mu\text{g m}^{-3}$ ; and winter: 54 compounds, 2901  $\mu\text{g m}^{-3}$ . The detected compounds included sulfur compounds, oxygenated compounds, aromatics, hydrocarbons, halogenated compounds, and terpenes. Oxygenated compounds were the most abundant compound in most samples. Isobutane, ethyl alcohol, limonene, butane, toluene, and trichlorofluoromethane were recognized as the most abundant compounds on the working surface throughout the year. This study would bring new light in assessing the particle pollution in urban areas and the effect of trace components on landfill odor.

© 2014 Elsevier Ltd. All rights reserved.

## 1. Introduction

Trace components emitted by landfills have long been in concern due to the potential risks they might pose both to human health and to the environment. Typical composition of trace components is reported to be subdivided into several chemical groups, including sulfur compounds, oxygenated compounds (alcohols, aldehydes, ketones, acids, esters), aromatics, terpenes, halogenated compounds, saturated and unsaturated hydrocarbons, etc. (Dincer et al., 2006; Sadowska-Rociek et al., 2009). Although most of these species are present in low concentrations (numbers for the range in ppm or ppb), their adverse effects on the environment and human health cannot be neglected. Compounds with low odor thresholds (e.g. sulfur compounds, oxygenated compounds) might generate serious odor and cause olfactory nuisances to adjacent communities. Some compounds such as tetrachloromethane,

dichloromethane, toluene and benzene attract attention for their toxicological importance (Durmusoglu et al., 2010). Besides, the oxidation of some volatile organic compounds (VOCs), like alkanes, alkenes, aromatic hydrocarbons, oxygen and nitrogen containing compounds as well as terpenes could form secondary organic aerosols (SOAs), which are significant contributors to the increasing  $\text{PM}_{2.5}$  pollution in Beijing (Chu et al., 2013).

Typical sources of trace components emissions in a landfill generally include the dumping area, leachate disposal pool, gas extraction wells and vehicles (McKendry et al., 2002; Sironi et al., 2005). Several studies have been focusing on the different emitted components from those sources (often regarded as VOCs, none methane organic compounds (NMOCs) or odorous gas) (Staley et al., 2006; Fang et al., 2012; Zhang et al., 2012a, 2012b). Allen et al. (1997) investigated the trace organic compounds at monitoring points from the gas extraction systems in seven U. K. landfills, identifying over 140 different VOCs, where more than 90 were common to all seven sites. Davoli et al. (2003) addressed the characterization of odorants emission from fresh wastes, old wastes, biogas and leachate by using solid-phase micro-extraction (SPME) and gas-chromatography–mass-spectrometry (GC/MS) and

\* Corresponding author. Room 803, Sino-Italian Environmental and Energy Efficient Building, School of Environment, Tsinghua University, Beijing 100084, PR China.

E-mail address: [luwenjing@tsinghua.edu.cn](mailto:luwenjing@tsinghua.edu.cn) (W. Lu).

established specific markers of olfactory pollution. Limonene was found to be a typical tracer of fresh waste, and *p*-cymene was the characteristic compound of leachate and biogas. VOCs emitted by open cells and compaction vehicle exhaust were also investigated (Chiriac et al., 2007). It was found that the activity of vehicles on site were responsible for high VOC emissions such as toluene. On the other hand, the agitation and compaction of waste also made great contributions to total VOC emission. Kim (2006) and Kim et al. (2005,2006) focused on the malodorous reduced sulfur (RSC) and aromatic compounds emission in landfill gas (LFG) of some landfills in Korea and stated that H<sub>2</sub>S could be used as the most sensible indicator of RSC emission in terms of both concentration and flux estimates. They also found out that concentration levels of major aromatics differed with landfill ages, and toluene was the dominant aromatic VOC in LFG under most circumstances.

Landfilling is the dominant disposal method for municipal solid waste in Beijing, where nearly 80% of MSW is landfilled in 2009 (Wang and Wang, 2013). Considering the high content of food waste (generally taking 40%–60% of the total weight) in MSW (Chen et al., 2010; Zhang et al., 2010), large quantities of trace components might be emitted, especially in the initial fermentation stage. However, few studies had been focused on the emission characterization of trace components in landfills in northern China; information on seasonal variations of the odorous gases-concentration are even less.

The main aim of the present research was to characterize the temporal variations (seasonal and daily) of trace components released during landfilling operations in Beijing, casting a new light on source-tracking for serious aerosol pollution in this important city of mainland China.

## 2. Materials and methods

### 2.1. Landfill description

Asuwei landfill, which is the largest sanitary landfill in Beijing, was chosen as the study site where the sampling process was performed. This landfill was constructed and started operation in 1994. The area of the landfill is about 60.4 ha, with a designed filling capacity of  $1.19 \times 10^7$  m<sup>3</sup>. Asuwei landfill is a typical landfill in flat lands, with a height of 45 m above ground and 5 m beneath ground. The landfill receives approximately 3000 tons of waste per day, and a total of 9 million m<sup>3</sup> (about 75% of the landfill) was filled by the end of 2011. Under the current waste deposition pressure, the landfill is expected to close in about five years.

Asuwei landfill mainly deals with municipal solid waste (MSW) coming from the east and west districts of Beijing as well as parts of Chaoyang and Changping Districts. The landfill also accepts about 900 tons of composting residue from a nearby MSW composting facility. The compacted waste, except for the working face (i.e., the open cell), is covered with high-density polyethylene membrane. Given that residential areas are located close to the site, the landfill site has often been complained of olfactory nuisances. The manipulation of fresh waste over the working surface is believed to be the major source of odor pollution in this area.

### 2.2. Air sampling

Air sampling was conducted at the landfill dumping site on elected days from 2012 to 2013, representing the four different seasons of the year. Five samples were collected in each sampling spot. Three samples were collected during daytime (10:00, 14:00, 18:00) and two during nighttime (23:00, 3:00) (Table 1). Meteorological data (including temperature, wind speed, and humidity) on the working surface were also recorded during sampling

**Table 1**  
Sampling campaigns.

Seasons	Sampling time	Sample abbreviations				
		10:00	14:00	18:00	23:00	3:00
Spring	Mar.27–28, 2012	SP1	SP2	SP3	SP4	SP5
Summer	Aug.30–31, 2012	SM1	SM2	SM3	SM4	SM5
Autumn	Nov.8–9, 2012	AT1	AT2	AT3	AT4	AT5
Winter	Jan.23–24, 2013	WT1	WT2	WT3	WT4	WT5

(Table 2) to evaluate the influence of the working surface on trace component emission.

Samples were collected with a specially designed sampler (SOC-01, National Key Laboratory of Odor Pollution Control of EPA-China) (Fig. 1) at a height of approximately 1.5 m above the working surface of the landfill. The samples are taken at a height similar to that of people's breathing zone. Air samples were drawn into 8 L of bioriented polyester bags (Environmental Science and Technology Development Co., Ltd, China) by using a sampler system, which works based on the lung principle. The internal vacuum pump of the system draws air directly into the bag by evacuating the tightly closed atmospheric pressure vessel, in which a bag was placed. Odor-free bags that are impermeable to water and organics were used only once. Before sampling, the bag was washed twice by sucking and discharging air at the sampling points to minimize the influence of volatile organic compounds (VOCs) originating from the bag. Polytertrafluoroethylene sampling tubes were used as input and connection lines. Samples were transported to the laboratory and analyzed within 24 h.

### 2.3. GC–MS Analysis

Gas samples obtained were first pre-concentrated by cryogenic liquid nitrogen, according to the methodology of EPA TO14 (US-EPA, 1999, Compendium Method TO–14). A three-stage cold trap concentrator (Entench 7100, USA) was used with an injection volume of 400 mL. The pre-concentrated gas samples passed through a system, which comprises a gas chromatograph (GC, Agilent 7890A, USA) equipped with a mass selective detector (Agilent 5975C, USA) for analysis.

The GC column DB-5ms (60 m × 0.32 mm × 1.0 μm) was programmed with three different temperature ranges: from 35 °C to 150 °C at an increasing rate of 5 °C min<sup>-1</sup>; from 150 °C to 220 °C at an increasing rate of 15 °C min<sup>-1</sup>; and at 220 °C for 7 min. The flow rate of the carrier gas (He) was 1.5 mL min<sup>-1</sup>. The detector mass range was set from 15 *m/z* to 300 *m/z*, and the ionization voltage was 70 eV. The compounds were identified by comparing their retention times with the standards, and identified compounds were quantified by using the internal standard method.

## 3. Results and discussion

### 3.1. Composition and seasonal variation of trace components

A total of 41, 59, 66, and 54 species of trace compounds were quantified during the four seasons. The measured trace

**Table 2**  
Meteorological conditions during sampling.

Time	Temperature (°C)	Humidity (%)	Wind speed (m/s)
Spring	22.6 ± 8.1	36.4 ± 8.2	1.32 ± 1.08
Summer	30.6 ± 6.4	62.4 ± 17.8	1.49 ± 0.61
Autumn	10.6 ± 8.3	50.2 ± 19.0	1.03 ± 0.54
Winter	-2.6 ± 1.8	65.6 ± 14.7	1.88 ± 1.29

Download English Version:

<https://daneshyari.com/en/article/6340876>

Download Persian Version:

<https://daneshyari.com/article/6340876>

[Daneshyari.com](https://daneshyari.com)