

Effect of MSW source-classified collection on the emission of PCDDs/Fs and heavy metals from incineration in China

De-Zhi Shi^a, Wei-Xiang Wu^{a,*}, Sheng-Yong Lu^b, Tong Chen^b,
Hui-Liang Huang^c, Ying-Xu Chen^a, Jian-Hua Yan^b

^a Department of Environmental Engineering, College of Environmental and Resource Science, Zhejiang University, 310029 Hangzhou, PR China

^b State Key Laboratory of Clean Energy Utilization, Institute for Thermal Power Engineering, Zhejiang University, 310027 Hangzhou, PR China

^c Green Energy Environmental Protection Power Co. Ltd., Hangzhou, 310007 Zhejiang, PR China

Received 18 May 2007; received in revised form 2 September 2007; accepted 3 September 2007

Available online 11 September 2007

Abstract

Municipal solid waste (MSW) source-classified collection represents a change in MSW management in China and other developing countries. Comparative experiments were performed to evaluate the effect of a newly established MSW source-classified collection system on the emission of PCDDs/Fs (polychlorinated dibenzo-*p*-dioxins and dibenzofurans) and heavy metals (HMs) from a full-scale incinerator in China. As a result of presorting and dewatering, the chlorine level, heavy metal and water content were lower, but heat value was higher in the source-classified MSW (classified MSW) as compared with the conventionally mixed collected MSW (mixed MSW). The generation of PCDDs/Fs in flue gas from the classified MSW incineration was 9.28 ng I-TEQ/Nm³, only 69.4% of that from the mixed MSW incineration, and the final emission of PCDDs/Fs was only 0.12 ng I-TEQ/Nm³, although activated carbon injection was reduced by 20%. The level of PCDDs/Fs in fly ash from the bag filter was 0.27 ng I-TEQ/g. These results indicated that the source-classified collection with pretreatment could improve the characteristics of MSW for incineration, and significantly decrease formation of PCDDs/Fs in MSW incineration. Furthermore, distributions of HMs such as Cd, Pb, Cu, Zn, Cr, As, Ni, Hg in bottom ash and fly ash were investigated to assess the need for treatment of residual ash.

© 2007 Elsevier B.V. All rights reserved.

Keywords: Source-classified collection; MSW; Incineration; PCDDs/Fs; Heavy metals

1. Introduction

With rapid economic development and urbanization in China, the quantity of municipal solid waste (MSW) generated has increased at a rate between 8% and 10% per year over the past decades [1]. Expanding MSW production could have a great effect on the environment and public health as the disposal of MSW has become a serious problem in China. Landfilling presently accounts for more than 80% of MSW disposal in China [2]. With rising landfill costs, a severe scarcity of landfill sites, and enhancement of people's environmental consciousness, the government of China has been urged to consider alternative disposal methods. Thermal treatment using incineration technology has been proven as an attractive method of MSW disposal for many years due to the primary advantages of

hygienic control, volume reduction (about 90%), mass reduction (about 70%) and energy recovery [3,4]. Thus, incineration meets the requirements of relative harmlessness, mass decrement and resource recovery. Therefore, when the first MSW incinerator plant imported from Japan was built in Shenzhen in 1988, other incineration plants were constructed in Beijing, Shanghai, Hangzhou, Zhuhai and other big cities of China in the following years. At present, more than 140 incineration plants are in operation or under construction in China [1]. In Zhejiang Province there have been 9 incineration plants constructed with a capacity of 4400 t MSW/day and 12 others designed to dispose of 6600 t MSW/day under construction [5,6]. Among incineration plants in China, there are three major types of MSW incineration technologies, i.e., stoker, fluidized bed and rotary kiln. Most stoker technologies have been imported from abroad to this point, and cover more than 50% of the total incineration capacity in China [7].

However, incineration of MSW is sometimes considered a secondary pollution source because it generates many pollutants,

* Corresponding author. Tel.: +86 571 81604036; fax: +86 571 81604036.
E-mail address: weixiang@zju.edu.cn (W.-X. Wu).

including acid gases, heavy metals (HMs) and PCDDs/Fs (Polychlorinated dibenzo-*p*-dioxins and dibenzofurans). Although various kinds of air pollution control devices (APCD) have been developed and successfully operated to ensure exhaust gases meet the environmental protection standards, concerns about PCDDs/Fs, the most toxic compounds among the toxic combustion by-products (TCBs), and HMs in flue gas and fly ash, have been increasing. It is reported that there are three major factors that affect the formation of PCDDs/Fs and the transport of heavy metals in full scale incinerators: (1) composition of the waste feed (chlorine, water, and metal content), (2) furnace design (temperature, air supply methods, residence time), and (3) the types of APCD [8]. Up to now, most studies have focused on the determination of PCDDs/Fs and HMs emission in different types of incineration plants [1,9–11]. Little is known about the effect of type of feed waste on the emission of PCDDs/Fs and HMs in incineration.

Although MSW separation has been popularized in developed countries such as Germany, United States and Japan, almost all the MSW in China is mixed, and transported directly to incineration plants without sorting and separation. Due to the lack of source-classified collection, a large amount of recyclable material is lost through combustion. Establishing a ‘recycling-based society’ is the goal for reducing natural resource consumption and lessening the environmental burden. Therefore, MSW source-classified collection for recycling represents the future direction in China and other developing countries. On the other hand, unlike most western countries, net caloric value of Chinese MSW is relatively low because of higher water content. It is reported that the heat value of MSW in most Chinese cities is only around 4200 kJ/kg [7], which barely meets the lowest caloric value needed for incineration. As a result of source-classified collection and pretreatment, it is likely that the characteristics of MSW will be altered. Any variation of MSW properties will surely affect combustion performance. However, whether the change of MSW from source-classified collection and the resultant combustion performance will pose a negative influence on the generation of hazardous pollutants such as PCDDs/Fs and HMs during incineration has not yet been clarified.

Therefore, the main objective of this study was to evaluate the effect of a newly established MSW source-classified collection in China on the generation and emission of PCDDs/Fs during MSW incineration as compared with the conventional mixed MSW. In addition, distribution of HMs in bottom ash and fly ash was also investigated. Results of the study will be helpful to assess the efficiency of the established MSW source-classified collection system on the generation and control of hazardous pollutants in MSW incineration.

2. Materials and methods

2.1. MSW source classification and collection

MSW for the experiment was collected from Wenxin district, located in the west part of Hangzhou, the capital city of Zhejiang province, China. This district has been designated as a residential

area according to municipal planning. A national pilot program has been carried out in this district to explore an MSW source separation system since March 2006. Residents in the selected communities of the district were instructed to classify the domestic waste as harmful waste, dry waste and food waste, and place them separately into proper waste containers with colors of red, blue and grey, respectively. Harmful waste included batteries, fluorescent lamps, mercury thermometers, expired medicines, and pesticides having potential hazard to human health or the environment, and was sent to a plant especially designed for hazardous waste treatment. Dry waste containing many recyclables such as waste paper, metal cans, plastic bottles, glass bottles, old clothes and shoes was transported to a separation center for further sorting. Food waste included uneaten portions of meals, and trimmings and peelings from food preparation activities in kitchens. Due to its high content of water, food waste was collected by compaction vehicles and unloaded at a transfer station where it was further dewatered.

2.2. Pretreatment of source-separated MSW

In the separation center, dry waste such as newspaper, plastics, metal, and glass were manually sorted on the drag conveyor. In order to avoid leakage of leachate, food waste was hermetically loaded and transported to the transfer station. A vertical compress machine (YJC400A, Zoomlion Heavy Industry & Science, China) was used there for dewatering. It consists of a vertical compressor, a two-box waste bin (3700 mm × 1600 mm × 1400 mm), hydraulic system, sewage discharge system, and an electric operating system. With a working pressure and time of 9.8×10^5 Pa and 10 min, respectively, food waste was compressed and dewatered mechanically. The pre-sorted dry waste and dewatered food waste were then transported together to an incineration plant. Mixed MSW for comparative research was also collected from the same communities of the district without source separation and additionally dewatered by compressive machine according to the conventional collection system. Both kinds of waste were stockpiled in the storage pit of the incineration plant for 36 h before combustion. Characteristics of the feed waste such as density, composition, moisture, combustibles, ash, heat value and chemical elements were analyzed according to the ‘sampling and physical analysis method for MSW’ [12].

2.3. Incineration facility

The comparative experiments were performed in Green Energy MSW Incineration Plant in Hangzhou (Green Energy Environmental Protection Power Co. Ltd.). The plant began to operate in 2004, and consists of three parallel stoker incinerators. Each one has its own heat recovery system and semi-dry air pollution control device (APCD). A schematic flow diagram of the incinerating facility is shown in Fig. 1. Each Mitsubishi Martin inversely-transported style incinerator with a capacity of 150 t/d was imported from Japan. The semi-dry APCD is composed of a semi-dry scrubber, activated carbon injector and a bag filter. $\text{Ca}(\text{OH})_2$ was sprayed into the semi-dry scrubber which is

Download English Version:

<https://daneshyari.com/en/article/583158>

Download Persian Version:

<https://daneshyari.com/article/583158>

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