Investigation of dioxin emissions from wastes incineration process in China

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Introduction

Incineration has been a preferred option to dispose municipal solid wastes (MSW), medical wastes and hazardous wastes in China. In 2002, China already had the capacity to burn 13,155 tons of wastes per day. According to a national program, 31 central hazardous waste incineration plants and 300 medical waste incineration plants will be built by 2006. Dioxin generated from combustion brings great dangers to the environment. The investigation of dioxin in the flue gas and fly ash was carried out to evaluate the dioxin emission and to select the best available techniques to minimize PCDD/Fs formation.

Materials and Methods

(1) Investigation of dioxin in the flue gas

Seven incinerators were chosen to detect the dioxin concentration in the flue gas. The characteristics of those incinerators were listed in Table 1. The samples were treated with a series of procedures and then detected by HRGC/HRMS[1].

Table 1 Incinerator conditions

Incinerator type	*Capacity (t/d)*	*Stack gas cleaning system*
Chain grate	120	Half dry lime scrubbing active carbon bag house
Fluidized bed	150	Half dry lime scrubbing bag house
Cement kiln	30	Half dry lime scrubbing active carbon bag house
Pyrolysis & Gasification	100	liquid spray
Reciprocating grate	50	Half dry lime scrubbing bag house
Martin grate	150	ESP
Air control pyrolysis	100	None

(2) Investigation of dioxin in the fly ash

Five incinerators in Southeast China were selected to test fly ash samples. Samples were treated following a standard procedure.

Results and Discussion

(1) Dioxin concentration in flue gas

In China, about 63.0 percent of incinerated MSW was burnt by grate furnaces; 26.2 percent was combusted in fluidized bed incinerators. The dioxin concentrations in the clean treated flue gas were listed in Table 2. The results show that PCDD/Fs fluctuated greatly from 0.006 to 46.08 ng-TEQ/m^3. Among all types of incinerators, the flue gas from cement kiln contained the lowest dioxin concentration. PCDD/Fs in most samples exceeded the national standard of 1.0 ng-TEQ/m^3 for MSW combustion process prescribed by State Environmental Protection Administration of China[2, 3].

Table 2 PCDD/Fs concentration in flue gas

Incinerator	*TEQ ng TEQ/m^3*		
	PCDDs	*PCDFs*	*Total*
Chain grate(test 1)	5.57	5.40	10.97
Chain grate(test 2)	5.17	13.66	18.83
Fluidized bed	3.28	11.67	14.95
Cement kiln(test 1)	0.0020	0.0040	0.0060
Cement kiln(test 2)	0.0042	0.0083	0.013
Pyrolysis & Gasification	14.47	31.61	46.08
Reciprocating grate	0.16	0.42	0.58
Martin grate(test 1)	0.25	0.80	1.05
Martin grate(test 2)	0.37	1.18	1.55
Air control pyrolysis(test 1)	0.86	2.86	3.72
Air control pyrolysis(test 2)	1.21	3.64	4.86
National standard 1.0			

Small incinerators can not run steadily, which is regarded as the main reason for the high PCDD/Fs concentration in the flue gas. At the same time, many incineration plants lack effective flue gas cleaning systems and some plants even have no such equipment. High moisture of MSW and low LHV cause bad combustion process. The components of feed stocks and LHV change greatly in China. Moreover, poorly operated incinerators were used to treat mixture of MSW and flammable industrial wastes in some cities.

(2) Dioxin concentration in fly ash

The fly ash samples were collected from five incinerators in Southeast China. Among them, one incinerator burned medical wastes while the others combust MSW[4]. The dioxin concentrations in the fly ash samples were presented in Table 3.

Table 3 Total dioxin concentration in fly ash

Incinerator	Medical wastes incinerator	MSW Incinerator ( )	MSW Incinerator ( )	MSW Incinerator ( )	MSW incinerator ( )
PCDDs	20.69	0.17	1.62	0.83	0.32
PCDFs	70.95	0.17	2.18	1.46	2.65
PCB	2.63	0.01	0.15	0.05	0.01
Total	94.27	0.35	3.95	2.34	2.98

In four MSW fly ash samples, the dioxin TEQ concentration changed from 0.35 to 3.95 ng-TEQ/m^3. PCDD/PCDF in the medical incinerator fly ash was 94.27 ng-TEQ/m^3. Fly ash generated from medical waste incinerators may cause great dangers to the environment[4].

The distribution of PCDD/Fs congeners was also analyzed. The results show that the distributions of dioxin congeners were quite similar for MSW fly ash, while those of medical wastes incinerators were different. The concentration of higher-chlorinated congeners of PCDD/Fs in the fly ash was remarkably higher than that of lower chlorinated congeners. PCDD/Fs count for more than 90 percent of the total amount of PCDD/Fs and PCBs.

(3)Estimation of dioxin generated from MSW combustion

Waste combustion is a main source for dioxin release. Based on the investigation of dioxin in both flue gas and fly ash, we estimated the total dioxin produced in the waste incineration process.

In 2002, China could burn 13,155 tons of municipal solid wastes per day. Assume that the incinerators operate 300 days per year, the total MSW combusted was 395×10^4 t/a. The LHV of MSW was about 1000-1500 kcal/kg and the air fuel ratio was assumed 2.0 for all incinerators. Then the flue gas output was 3500 5000 Nm^3/t-MSW. The quantity prediction of MSW incineration from 2005 to 2020 was presented in Figure 1.

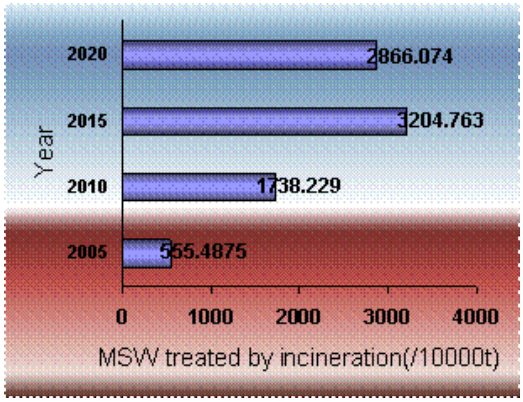
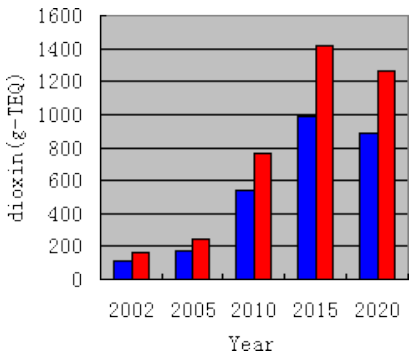


Figure 1 Prediction of total amount of MSW combustion in China

According to data in Table 2, the mean dioxin emission from grate furnace and the fluidized bed furnaces was set at 8.1ng-TEQ/m^3 and 14.95ng-TEQ/m^3 respectively. Wastes burnt by grate furnace were about 2.5 times of those burnt by fluidized bed furnaces. Then the dioxin emission from MSW incinerators from 2002 to 2020 was estimated and the data are shown in Figure 2. The red bar presents the maximum value while the blue bar was the minimum value of the prediction.



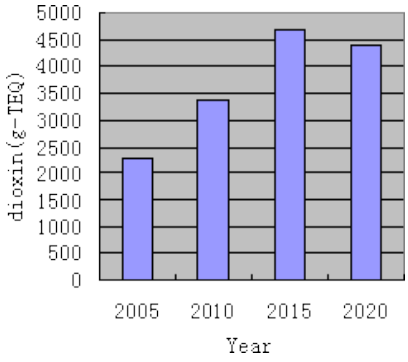


Figure 2. Prediction of dioxin in flue gas Figure 3. Prediction of dioxin in fly ash

The mean concentration of dioxin in the fly ash produced from MSW and medical wastes incineration were 3.0 ng-TEQ/g and 90.0ng-TEQ/g respectively (Table 3). The fly ash output was 3% of the combustion wastes amount. According to Figure 1, the fly ash generated from MSW incineration plants from 2005 to 2020 will be 16.7×10^4t/a (2005), 52.1×10^4t/a (2010), 96.1×10^4t/a (2015) and 86.0×10^4t/a (2020). In 2002, 65×10^4 tons of medical wastes were burnt. Assume that the amount of medical wastes combusted will not increase, the fly ash generated from medical wastes incineration plants will be 2.0×10^4t/a (2005 to 2020). The estimated total amount of PCDD/Fs in fly ash generated from MSW and medical wastes combustion from 2005 to 2020 was presented in Figure 3.

Acknowledgements

The work was supported by Ministry of Science and Technology of China and National Natural Science Foundation of China.

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