EMISSION BEHAVIOR AND REMOVAL EFFICIENCY OF DIOXIN IN A MUNICIPAL SOLID WASTE INCINERATOR IN TAIWAN

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Introduction

The incineration of MSW (municipal solid waste) is becoming the dominant means of waste treatment in Taiwan because of the lack of landfill sites. Government policy of constructing more MSW incinerators is being delayed due to the public fear of dioxin risk. The government has, therefore, issued the three T (3-T) controlled criteria and enforced the regulations of 0.1 ng-TEQ/Nm^3 dioxin permit-level. The regulations are applied to new and existing large MSW incinerators[1]. Countermeasures such as the development and validation of national standard methods for sampling and analysis of dioxins, funding for dioxin related research and monitoring projects etc. have also been implemented. The law mandates each MSW to annually perform five dioxin analyses of the stack-emissions. The average of the three middle values is subjected to regulatory control. Even so, the representative and reliability of the reported emission value is still been challenged. To address this issue, this study was carried out to investigate the emission behavior and removal efficiency of dioxin in a large MSW during a two-month period. The MSW incinerator has four incineration lines, each with a daily capacity of 400 metric tons. The APCD (air pollution control device) consists of lime plus activated carbon (AC) injection in a semi-dry scrubber (SDS) and a bag-house filter (BF).

Methods and Materials

Composition analysis of the waste was performed to investigate if the characteristics of the waste could affect the emission behavior of dioxin. Three samplings were performed during a two-month period. A solid sample of slag and fly ash, and a gas sample from the SDS entrance (designated as point A) and stack-emission were simultaneously collected during each sampling. During the 3rd sampling time, an additional gas sample from the BF entrance (designated as point B) was collected. Gaseous samples from A and B are designated as process. The Taiwan EPA standard methods for sampling[2] and analysis[3] of dioxins and furans in stack-emission were used. US EPA method 1613B[4] was used for the analysis of slag and fly ash samples. HRGC/HRMS analyses were carried out at a 10,000 mass resolution on a VG AutoSpec Ultima coupled to a HP 6890 GC system with a 60m x 0.25mm x 0.25μm DB-5MS column.

Results and Discussion

Typical result of waste composition analysis is shown in Table 1. The characteristic of the waste does not affect the dioxin emission behavior. Analytical results for each sample using International Toxic Equivalent Factors (I-TEF) are shown in Figure 1. The dioxins in the stack-emission are all within the permit-levels, although a measured concentration of 0.18 ng-TEQ/Nm^{3}was found on 30 October. Numerical results of the emission behavior and removal efficiency of dioxin are summarized in Table. 2. The dioxin concentration in the slag ranges 2.45 to 16.13

pg-TEQ/g(average 7.26 pg-TEQ/g); in the fly ash ranges from 576.29 to 4842.85 pg-TEQ/g (average 1373.29 pg-TEQ/g); in the stack-emission ranges from 0.035 to 0.182 ng-TEQ/Nm^3 (average 0.07 ng-TEQ/Nm^3); in the process ranges from 1.39 to 15.75 ng-TEQ/Nm^3(average 4.74 ng-TEQ/Nm^3). The similar pattern between the fly ash and stack-emission implies a relationship exists between them.

The PCDD/PCDF ratio of the samples in different sampling date and point is graphically expressed in Figure 2. The larger the PCDD/PCDF ratio is the lower the dioxin in the stack-emission, i.e., during the 2nd sampling period. Similarly, the smaller the PCDD/PCDF ratio is the higher the dioxin in the stack-emission, i.e., during the 3rd sampling period. The highest measured concentration of 0.18 ng-TEQ/Nm^3 found on 30 October corresponds to the lowest PCDD/PCDF ratio of 0.23. The PCDD/PCDF ratio might, therefore, be used as an indicator of the dioxin concentration in the stack-emission.

Table 2 shows the dioxin removal efficiency ranging from 97% to 99% (average 98 %). This efficiency agrees with the reported removal efficiency of 97-98% attained by injecting activated carbon and bag-house filter[5]. A detailed inspection of Figure 1 reveals that SDS contributes about 30% removal efficiency. The removal efficiency for each congener during the 3rd sampling period is shown in Figure 3. The removal efficiency appears to decrease with higher chlorinated PCDD and PCDF. This pattern is desired because the less chlorinated and more toxic congeners are effectively removed.

Table 1.A typical result of composition analysis of waste being incinerated

		Wet base wt. (kg)	Dry base wt. (kg)	Moisture (%)
Combustible				
1	Paper	5.82	2.8	30.94
	(Al foil package)	0.46	0.36	1.02
	(Recyclable)	2.84	1.44	14.34
	(Non- recyclable)	2.52	1	15.57
2	Textile	0.38	0.2	1.84
3	Wood	0.9	0.4	5.12
4	Food	8.28	3.22	51.84
5	Plastics	2.68	1.78	9.22
	(Common plastic)	2.32	1.42	0.00
	(PET bottle)	0.06	0.06	0.00
	(Blister plastic container)	0.1	0.1	0.00
	(Other plastic container)	0.2	0.2	0.00
6	Leather	0	0	0.00
7	Others	0.32	0.32	0.00
Sum		18.38	8.72	98.98
Non-combustible				
8	Metal	0.52	0.52	0.00
	(Common Metal)	0	0	0.00
	(Iron can)	0.38	0.38	0.00
	(Al can)	0.1	0.1	0.00

	(Battery)	0.04	0.04	0.00
9	Glass	0.02	0.02	0.00
	(Common glass)	0.02	0.02	0.00
	(Glass container)	0	0	0.00
10	Ceramic	0.02	0.02	0.00
11	Sand	0.64	0.54	1.02
Sum		1.2	1.1	1.02
Total		19.58	9.82	100.00

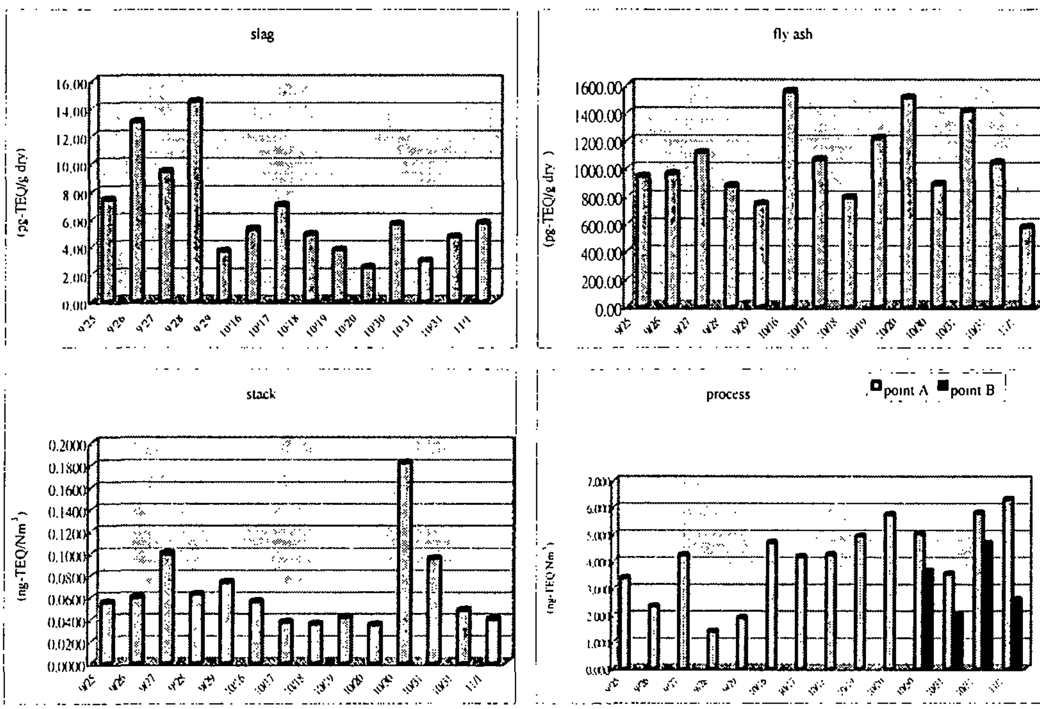

Figure 1. Analytical results of dioxin concentration for each sample

Table2. Numerical results of the emission behavior and removal efficiency of dioxin

TEQ	Period 1		Period 2		Period 3		Period 1~3	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Slag (pg-TEQ/g)	9.58	4.36	4.64	1.70	4.73	1.28	6.43	3.61
Fly ash (pg-TEQ/g)	926.34	133.93	1227.30	317.77	978.94	347.98	1048.85	289.93
Stackgas(ng-TEQ/Nm^3)	0.07	0.02	0.04	0.01	0.09	0.07	0.07	0.04
Process gas at A (ng-TEQ/Nm^3)	2.64	1.15	4.76	0.63	5.16	1.20	4.12	1.48
Removal efficiency (%)	97.00	1.18	99.12	0.22	98.08	1.46	98.06	1.34

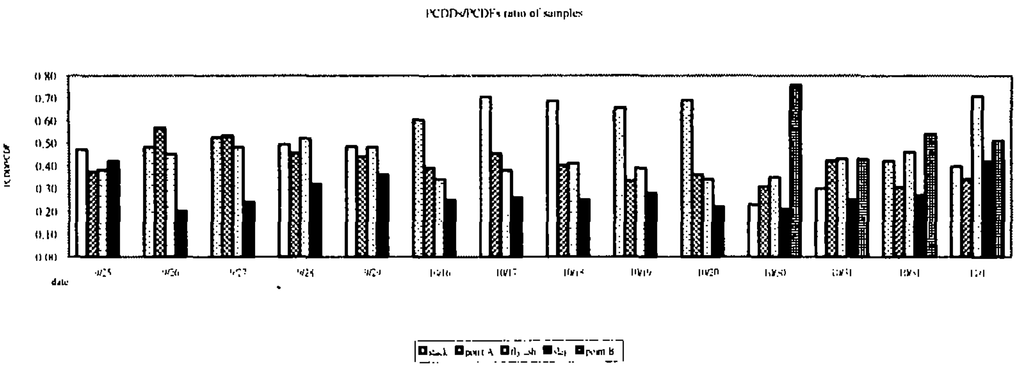

Figure 2. The PCDD/PCDF ratio of samples collected in different sampling date and point

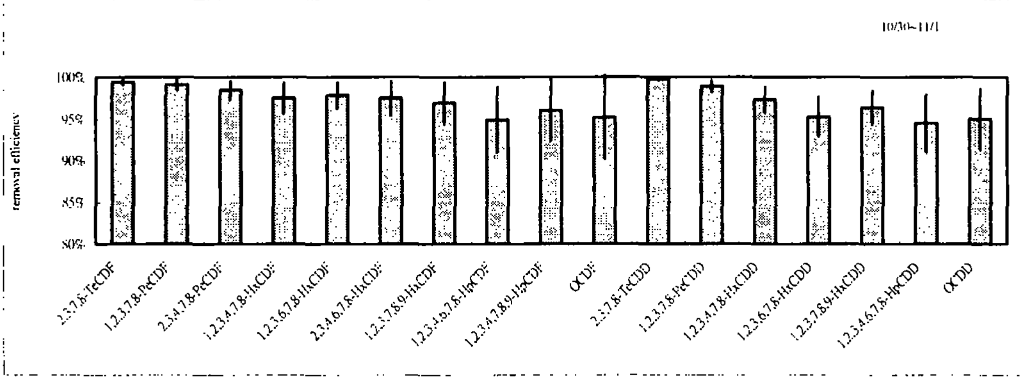

Figure 3. The dioxin removal efficiency for each congener during the 3rd sampling

Acknowledgements

The authors are thankful to the Taipei City Government of the Republic of China (PT-89-102) and National Tsing Hua University for their financial support.

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