VARIATION OF PCDDs/PCDFs CONCENTRATION IN PERIPHERAL UTILITIES OF MUNICIPAL SOLID WASTE INCINERATOR

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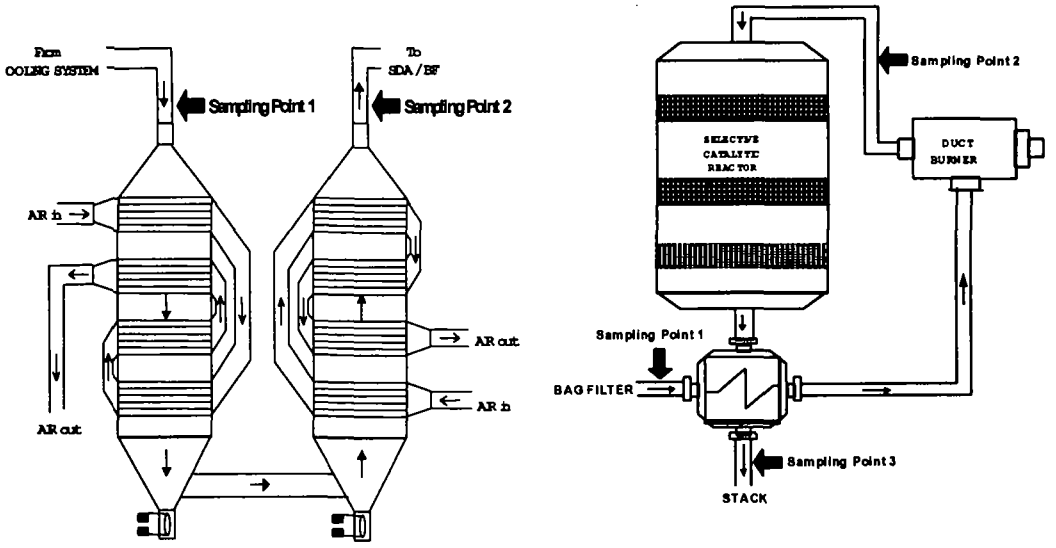
Introduction

The commercial-scale municipal solid waste (MSW) incinerator has the peripheral utilities such as air pre-heater for preheating combustion air and preventing white smoke and gas/gas heat exchanger with duct burner for re-heating the flue gas for selective catalytic reduction (SCR) process. Incineration facilities are designed and constructed on the basis of energy-effective processes. But, these energy-effective processes could be resulted in PCDDs/PCDFs re-synthesis problem[1]. In this study, a commercial-scale MSW incinerator was selected to investigate how much PCDDs/PCDFs are re-synthesized in peripheral utilities, and thus to provide the proper design and management information for incineration facilities.

Material and Methods

A MSW incineration facility with the treatment capacity of 100 ton/day, which has peripheral utilities such as air pre-heater and SCR gas re-heater (gas/gas heat exchanger with duct burner), was selected to investigate whether PCDDs/PCDFs are re-synthesized in these peripheral utilities or not. At the inlet and the outlet of these peripheral utilities of the MSW incinerators, samples were collected five times simultaneously and their sampling points are given in Fig. 1. The PCDDs/PCDFs samples were divided into two phases such as particulate and gaseous phase, and extracted and analyzed separately according to the Korean Standard Testing Method for Dioxins and Furans[2]. The particulate and the gaseous phase PCDDs/PCDFs were analyzed by HRGC/HRMS (*High Resolution Gas Chromatograph/ High Resolution Mass Spectrometer*: Micromass Co., Autospec Ultima) above 10,000 resolution with SP-2331 column of 60m x 0.32mmID x 0.25μm. Operation conditions of the HRGC/HRMS during PCDDs/PCDFs analysis are given in Table 1. TEQ (Toxic Equivalents as 2,3,7,8-TCDD) values were calculated by using I-TEF(International-Toxicity Equivalency Factor).



(a) Air pre-heater (b) SCR gas re-heater

Fig. 1. Sampling points of air pre-heater and SCR gas re-heater for PCDDs/PCDFs.

Table 1. GC/MS analytical condition of PCDDs/PCDFs

Parameters	PCDDs/PCDFs
Injector	250 °C
Column	SP-2331 (60 m x 0.32 mm ID x 0.2 μm)
Oven	120 °C (3 min) → 10 °C/min to 200 °C (3min) → 3 °C/min to 265 °C (15min)
Carrier Gas	He, 2.5 ml/min
Ionization	EI, 36 eV
Ion Source	270 °C
Resolution	> 10,000
Monitoring	4 Function, SIM (Selected Ion Monitoring)

Results and Discussion

Incineration process of the MSW incineration facility studied is given in Fig. 2[3]. In air pre-heater, as shown in Fig. 3, the PCDDs/PCDFs concentration at the outlet were three times higher than those at the inlet by representing 0.438 ng-TEQ/Nm^3 at the inlet and 1.445 ng-TEQ/Nm^3 at the outlet respectively. The particulate-phase PCDDs/PCDFs concentrations at the outlet were about 9.5 times higher than those at the inlet, while gaseous phase PCDDs/PCDFs concentrations were decreased to two thirds of those at the inlet. This enrichment of PCDDs/PCDFs, as shown in Fig. 2, seemed to be resulted from the fact that the flue gas passed the 300°C of re-synthesis temperature window of PCDDs/PCDFs when the flue gas was cooled down from 383°C to 250°C. Meanwhile, significant amounts of PCDDs/PCDFs were re-synthesized at the outlet of air pre-heater in comparison to the PCDFs by representing that the ratios of PCDFs to PCDDs were 76 : 24 at the inlet and 64 : 36 at the outlet. Two major 2,3,7,8-substituted congeners were 2,3,4,7,8-PeCDF and 1,2,3,7,8-PeCDD, and their TEQ values were 53 % and 46 % of the total TEQ values at the inlet and the outlet, respectively.

In SCR gas re-heater, as shown in Fig. 4, the outlet PCDDs/PCDFs concentration of 0.064 ng-TEQ/Nm^3 were 3.7 times higher than the inlet of 0.237 ng-TEQ/Nm^3. Like the same re-synthesis trend as air pre-heater, particulate phase PCDDs/PCDFs concentrations at the outlet were 10 times higher than those at the inlet, while gaseous phase PCDDs/PCDFs concentration were decreased to 50 % of those at the inlet. Consequently, the net destruction and removal efficiency by SCR was about 60% since the PCDDs/PCDFs emission concentration at the stack was 0.094 ng-TEQ/Nm^3 (gaseous phase 0.007 ng-TEQ/Nm^3 and particulate phase 0.087 ng-TEQ/Nm^3). On the other hand, the PCDFs were relatively much re-synthesized at the out of SCR re-heater rather than the PCDDs by representing that the ratios of PCDFs to PCDDs were 45:55 at the inlet and 60:40 at the outlet. Two major 2,3,7,8-substituted congeners were 2,3,4,7,8-PeCDF (0.013 ng-TEQ/Nm^3) and 1,2,3,6,7,8-HxCDD (0.010 ng-TEQ/Nm^3) at the inlet, but 2,3,4,7,8-PeCDF (0.080 ng-TEQ/Nm^3) and 1,2,3,7,8-PeCDD (0.015 ng-TEQ/Nm^3) at the outlet. And thus their TEQ values were 37 % and 49 % of the total TEQ values at the inlet and the outlet, respectively.
Therefore, this investigation concluded that the proper control of temperature in peripheral utilities of MSW incineration facility seemed to be a critical point for the enrichment of PCDDs/PCDFs.

Incinerator (895 °C)→ Water Spray Tower (383 °C) → Air Pre-heater (249 °C) → SDA/BF (164 °C) → Gas Re-heater for SCR (293 °C)→ SCR → Stack (196 °C)

Fig. 2. Incineration process of MSW incinerator studied.

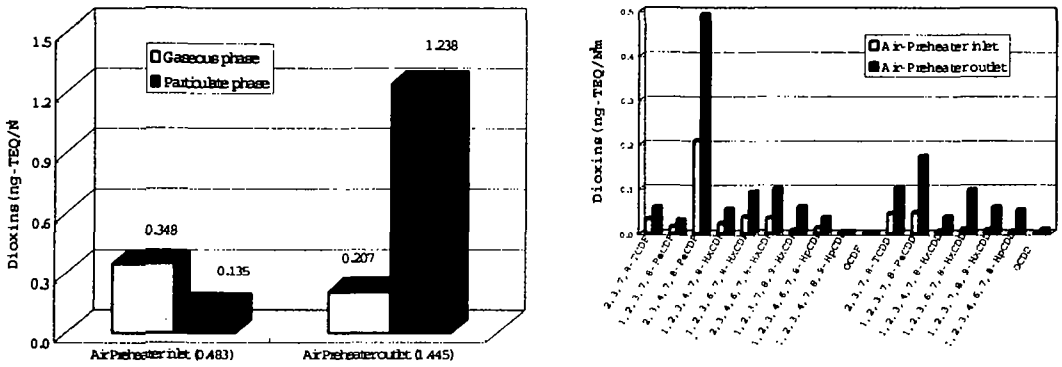


Fig. 3. PCDDs/PCDFs concentration variation and 2,3,7,8-congener profile at the inlet and the outlet of air pre-heater of MSW incineration facility.

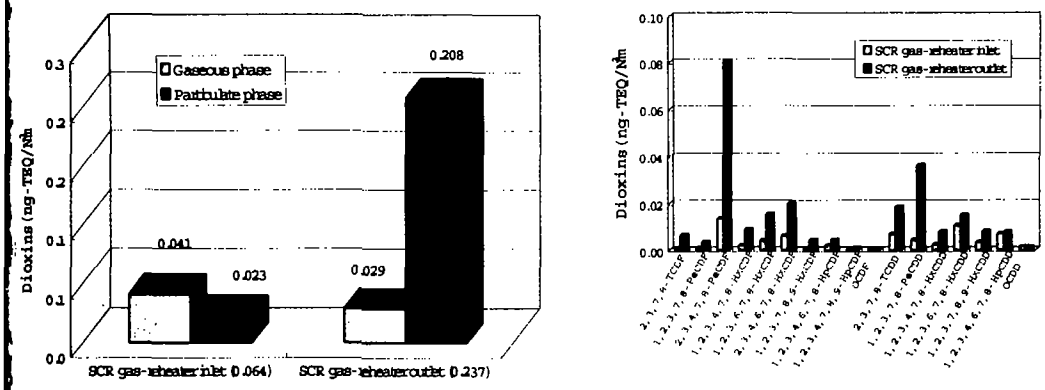


Fig. 4. PCDDs/PCDFs concentration variation and 2,3,7,8-congener profile at the inlet and the outlet of SCR gas re-heater. of MSW incineration facility.

References:

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