Behavior of PCDDs/PCDFs Homologues at Inlet/Outlet of Baghouse under Stable MSW Combustion

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Introduction

It is known that complete and stable combustion could be a precondition for depressing poly-chlorinated dibenzo-*p*-dioxins and dibenzofurans (PCDDs/PCDFs) formation in a municipal solid waste (MSW) incinerator.[1)] In order to obtain such desirable conditions, automatic combustion control (ACC) systems are equipped to most of modern incineration plants. While conventional ACC systems have the purpose to achieve low NOx and CO emission, we have recently developed a new type of ACC system which not only depresses the emission of pollutants, but also stabilizes the steam flow from the associated boiler.[2)] This newly developed ACC called 'Hybrid ACC' consists of a fuzzy logic based controller, which adjusts the cooling air and water spray to reduce CO and NOx concentrations, and a simulation model based controller, which stabilizes the steam flow and inner temperature. It can therefore easily provide extremely stable and low CO emission and constant, high level temperatures in a secondary combustion zone. Accordingly, formation of dioxins could be also reduced using this system. This study shows the findings on PCDDs/PCDFs homologue patterns obtained from flue gases at the inlet and outlet of a baghouse on a large scale incinerator, that is operated with the conventional and with this new Hybrid ACC system.

Experimental Methods

Several series of measurements were carried out at a full-continuous stoker-type MSW incinerator having a normal throughput of 150 tons/day. The train of installations with temperatures are shown in Figure 1. To elucidate the difference in stability of combustion, the incinerator was operated using alternatively the conventional type and the new Hybrid type of ACC. Besides temperatures at an inlet of the baghouse were adjusted at 235°C and 193°C. To keep the lower temperature at 193°C, feed rate was reduced to 120 tons/day because of limited performance of the gas cooler. Although the flue gases were sampled at the boiler outlet, the baghouse inlet and outlet and the SCR outlet, only the two sets of data for the baghouse inlet and outlet are shown in this paper. PCDDs/PCDFs sampling and analyses followed the procedures of the Waste Research Foundation of Japan. The isomers of 1,3,6,8-

TCDD and 1,3,7,9-TCDD were analyzed for the purpose of characterizing the dioxin derivation. Chlorophenols(CPs) and chlorobenzenes(CBs) were also analyzed for all samples. CO concentrations were monitored continuously at the inlet of the stack during the sampling .

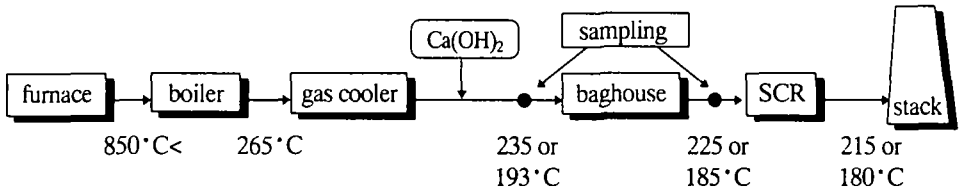

Figure 1. Schematic flow of the MSW incinerator.

Results and Discussion

Analytical results along with the operating conditions for four typical experiments are summarized in Table 1. Figure 2 shows their trend of CO concentration changes during the gas sampling.

Table 1. The settings of the experiments and their analytical results.

Run No.	unit	Run 1		Run 2		Run 3		Run 4	
Feed rate	t/d	150		150		120		120	
Sampling time	h	4		4		2		2	
ACC	-	Hybrid		Conventional		Hybrid		Conventional	
Furnace temp. ave.	°C	917		879		857		833	
Furnace temp. std.	%	18		40		16		27	
CO ave.	ppm	6.7		12.5		6.5		8.5	
CO max.	ppm	31		191		12		39	
Sampling point	-	inlet	outlet	inlet	outlet	inlet	outlet	inlet	outlet
Baghouse temp.	°C	235	229	236	229	193	185	193	187
PCDDs	ng/Nm^3	9.5	11	41	20	7.6	3.3	13	1.1
PCDFs	ng/Nm^3	36	21	80	34	37	13	25	7.7
PCDDs/PCDFs	ng/Nm^3	46	32	120	54	45	16	38	8.8
TEQ	ng/Nm^3	0.75	0.48	2.2	0.81	0.78	0.25	0.63	0.059
CPs	μg/Nm^3	2.7	5.8	3.5	8.0	1.3	1.1	0.81	0.80
CBs	μg/Nm^3	2.6	3.0	2.2	2.7	1.5	0.96	0.83	0.60
1,3,6,8-T4CDD	ng/Nm^3	0.13	0.58	0.22	1.2	*	*	*	*
1,3,7,9-T4CDD	ng/Nm^3	0.09	0.22	0.18	0.41	*	*	*	*
*TEQ at stack inlet	ng/Nm^3	*		0.25		0.046		0.066	

* not analyzed

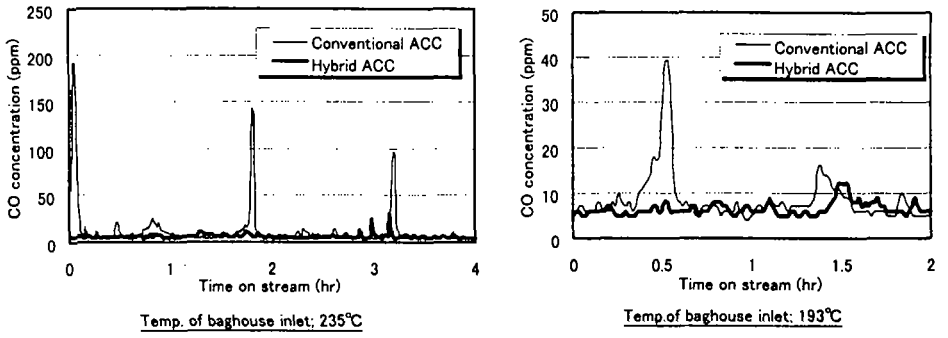

Figure 2. Changes of CO concentrations.

The Hybrid ACC gave extremely low and stable CO concentrations. Furthermore the temperatures at the secondary combustion zone were also stable over 850°C. On the contrary, a few peaks arose during the sampling under the conventional ACC operation, though the average concentrations were low enough. When the CO level was stable, the toxic equivalents of dioxins (TEQ), corrected to 12% O_2 at the inlet of baghouse, decreased to below 1 ng/Nm^3. After the baghouse, TEQ levels decreased with a decrease in temperature and seem to be affected by the CO level, i.e., the higher TEQ removal efficiencies were obtained when the CO peak arose. Homologue profiles of PCDDs/PCDFs are shown in Figure 3. At the inlet of the baghouse, concentrations of PCDFs were much higher than those of PCDDs in case of stable conditions, while once the combustion was disturbed those of both PCDDs/PCDFs increased, particularly for higher chlorinated PCDDs. Passing through the baghouse, concentrations of PCDDs/PCDFs decreased. Here, at a high temperature the distribution of the PCDD homologues differs from the behavior at lower temperatures, i.e., T4CDDs, P5CDDs and H6CDDs increase after the baghouse, while the higher chlorinated homologues (H7CDDs and OCDD) are removed. This tendency is similar to the study done by Lerner except for the behavior of PCDFs.[3] Both formation and adsorption of dioxins occurred on the fly ash attached to the bagfilter. Dioxins might be adsorbed on solid unburned organic substances contained in fly ash at low temperatures because the removal efficiency increased in high CO level conditions, but the TEQ levels in fly ash will increase under such inadequate conditions. Concentrations of CPs, known as precursors of PCDDs,[4] under unstable combustion at the baghouse inlet were higher than those under stable conditions. However, at a higher temperature the concentration of CPs and CBs increased over the bagfilter. At lower temperatures the increase did not occur. Hunsinger et al. also showed that CPs, together with dioxins, were generated on the fly ash even around 200°C.[5] At higher temperatures, 1,3,6,8- and 1,3,7,9-TCDD, which are condensations of CPs, also substantially increased over the baghouse. These phenomena obviously show that PCDD formation could take place at temperatures over 200°C.

These findings definitely show that stable combustion followed by filtration at lower than 200°C is needed to attain lower total dioxin emissions from MSW incinerators.

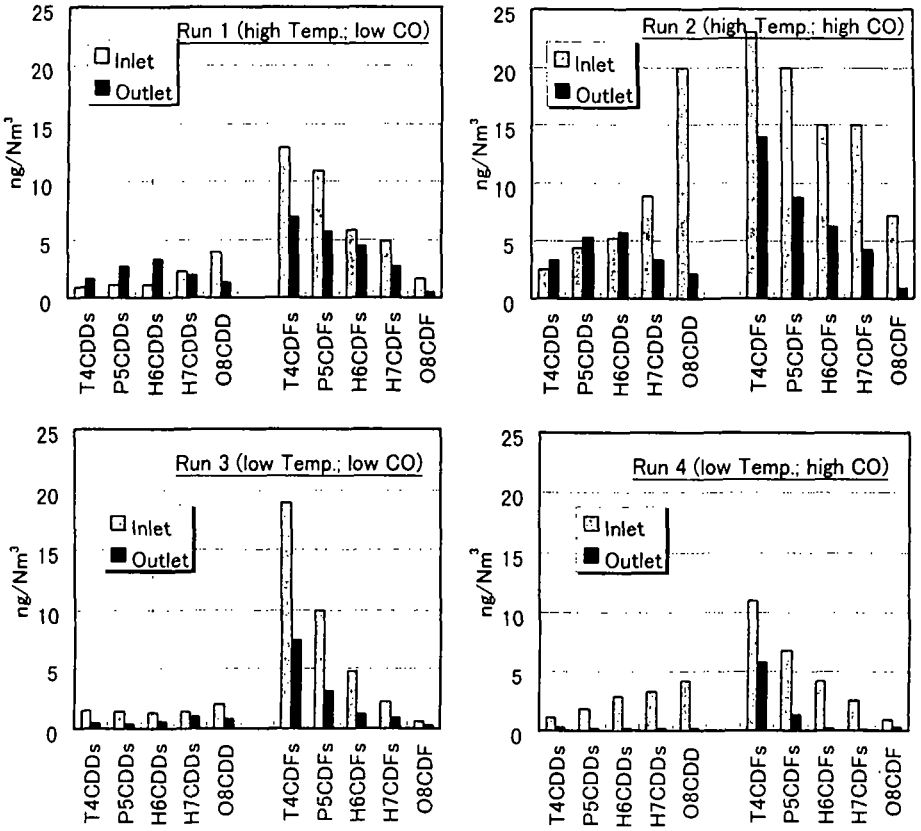

Figure 3. Distributions of PCDDs/PCDFs homologues.

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