CHARACTERIZATION OF PCDD/PCDFS IN STACK FLUE GAS AND IN THE ASHES OF APCDS FROM SOLID WASTE INCINERATOR

Guo-Ping Chang-Chien, Chung-Hsien Hung, Ber-Tin Lin,

Cheng-Ying Tsai, and Jiann-Yuan Yu

Department of Chemical Engineering and Super Micro Mass Research and Technology Center, Cheng-Shiu Institute of Technology, Kaohsiung 833, Taiwan.

INTRODUCTION

The polychlorinated dibenzo-*p*-dioxins (PCDDs) and dibenzofurans (PCDFs) have been the subject of much concern. 2,3,7,8-TCDD is particularly the most potent carcinogen ever evaluated by the US Environmental Protection Agency and has been associated with a remarkable variety of toxicological effects[1]. Some of these effects have occurred at extraordinarily low doses. Emissions from MSW incineration plants were dominant, contributing an average of 60% to the total emissions from industrial sources in UK[2]. PCDD/Fs could be emitted from flue gas as well as from fly ash collected by APCDs. In this study, characterizations of PCDD/PCDFs in stack flue gas, and various types of fly ashes from solid waste incinerator were investigated. For reducing the variables, only wood chips and air were fed into the combustor.

Methods and Materials

The solid waste incinerator investigated in this study is performed in batch, and only wood chips and air were fed into the combustor. There is no need of auxiliary fuel for incineration. The air pollution control devices for this incinerator are heat exchanger, cyclone, wet scrubber, and fabric filter in sequences.

The flue gas was sampled for PCCD/PCDFs in accordance with U.S. EPA Method 23, using a U.S. EPA MM5 sampling train. Before sampling, the XAD-2 resin was spiked with PCDD/PCDF surrogate standards. A total of four stack flue gas samples were taken on two different days, Day "A" and Day "B", respectively. Each stack flue gas was sampled for 3 hours. In additional, trip blanks and field blank were also taken and determined. The fly ashes were collected from combustion room, heat exchanger, cyclone, and fabric filter of the incinerator on Day "A",

respectively.

Dioxin analysis was followed by the USEPA Method 23 for flue gas samples and by the USEPA Method 1613 for the wood chips and ash samples, and was done in a certified lab. The measurement of PCDD/PCDFs was performed using a HP 6970 high-resolution gas chromatograph and a Micromass Autospec Ultimate (UK) high-resolution mass spectrometer. The I-TEQ was calculated using NATO (1989) international toxic equivalent factors (I-TEQs).

Results and Discussion

Concentration and profiles of PCDD/PCDFs in stack flue gas

The information of sampling time is showed in Table 1. The concentrations of 2,3,7,8-PCDD/PCDFs homologues in the stack flue gas on sampling day A and B are showed in Fig.1. The total concentrations of PCDD/PCDFs in the stack flue gas of A1, A2, A3, and B1 were 280, 50.9, 32.8, and 17.5 ng/Nm^3 (dry flue gas at normal condition 273K, 11% O_2), respectively. The total I-TEQ concentrations of PCDD/PCDFs were 22.6, 3.82, 3.54, and 1.23 ng I-TEQ/Nm^3, respectively. Fig. 1 also revealed that the stack flue gas profiles of PCDD/PCDFs were similar on two different days except A1. The reason is that the incineration condition is unstable during the start-up of incinerator and the unstable incineration causes the PCDD/PCDFs I-TEQ concentration of A1 6 times of magnitude higher than that of A3, which was sampled under stable condition.

TEQ contents of PCDD/PCDFs in wood chips and ash samples

The I-TEQ contents of 2,3,7,8-substituted PCDD/PCDFs in wood chips and ash samples are listed in Table 2. The TEQ ranges from 0.0057 ng/g in wood chips sample to 78.3 ng/g in fabric filter fly ash sample. It shows that PCDD/PCDFs are generated from combustion process, not originally from the waste, and APCDs, which are usually operated at an effective temperature for generating PCDD/PCDFs, are important sources of PCDD/PCDFs. The most favorable temperature range for chlorination of PCDD/PCDFs on fly ash is from 250 to 450℃, and activated carbon and residual organic compounds on fly ash can be converted to PCDD/PCDFs by de novo synthesis[3]. Besides temperature, particle size is also one of the factors that influence the PCDD/PCDFs content of the fly ash. Small particles usually have higher PCDD/PCDFs contents than those large particles because of their greater specific surface areas and longer residual time in flue gas. That is why the PCDD/PCDFs content of fabric filter fly ash is greater than that of cyclone fly ash by one order of magnitude.

Characteristic of PCDD/PCDFs homologue in ash samples

The Characteristic profiles of PCDD/PCDFs homologue in ash samples are shows in Fig. 2. It reveals that the fly ashes of the cyclone and fabric filter had lower fractions in OCDD and OCDF; in other words, relatively more lower-chlorine PCDD/PCDFs might be condensed onto the

fly ashes, which consequently increases the I-TEQ value.

PCDD/PCDFs profiles of stack flue gas and fly ash

The PCDD/PCDFs homologue profiles of stack flue gas A3 and fabric filter ash are showed in Fig. 3. Both profiles are quite similar, and it proves that fly ash is an important source of PCDD/PCDFs. Because PCDDs are less volatile than PCDFs[4], PCDD of fabric filter fly ash are higher than those of stack flue gas and on the contrary, PCDF of stack flue gas are higher than those of fabric filter fly ash.

Table 1 The sampling time on Day A and Day B

Sample No.	Time
The start-up of incinerator on sampling day A	8 : 00 AM
Sample A1	8 : 10 AM ~ 11 : 10 AM
Sample A2	12 : 00 PM ~ 3 : 00 PM
Sample A3	3 : 30 PM ~ 6 : 30 PM
The start-up of incinerator on sampling day B	8 : 00 AM
Sample B1	10 : 00 AM ~ 1 : 00 PM

Table2 TEQ(ng/g) of 2,3,7,8-substituted PCDD/PCDFs in wood chips and ash samples

	Wood Chips	Bottom Ash A	Bottom Ash B	Heat Exchanger Fly Ash	Cyclone Fly Ash	Fabric Filter Fly Ash
Temp.		900℃[a]	900℃[a]	470℃[b]	450℃[b]	250℃[b]
PCDD	0.0021	0.0901	0.0608	0.542	0.763	16.6
PCDF	0.0036	0.295	0.164	1.15	2.30	61.7
PCDD+ PCDF	0.0057	0.385	0.225	1.70	3.07	78.3

[a] Temperature of incineration

[b] Operation temperature of APCDs

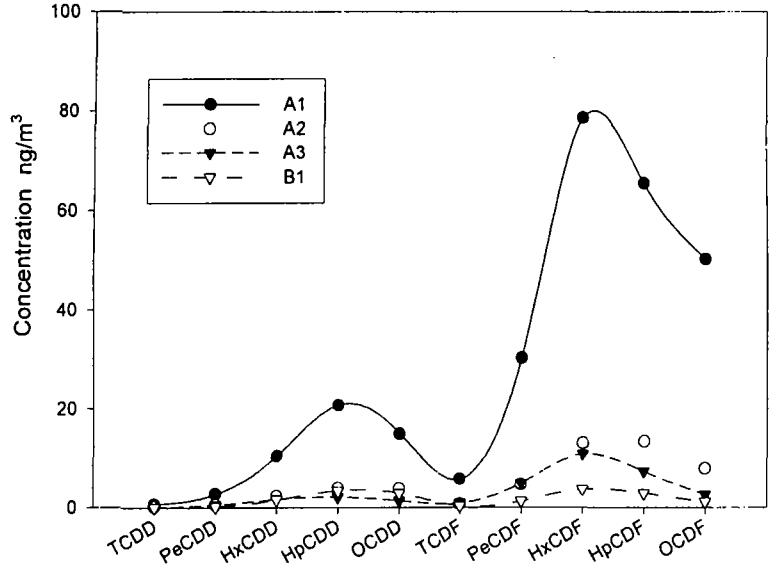

Fig.1 The concentration of PCDD/PCDFs in the stack fleu gas on sampling Day A and B

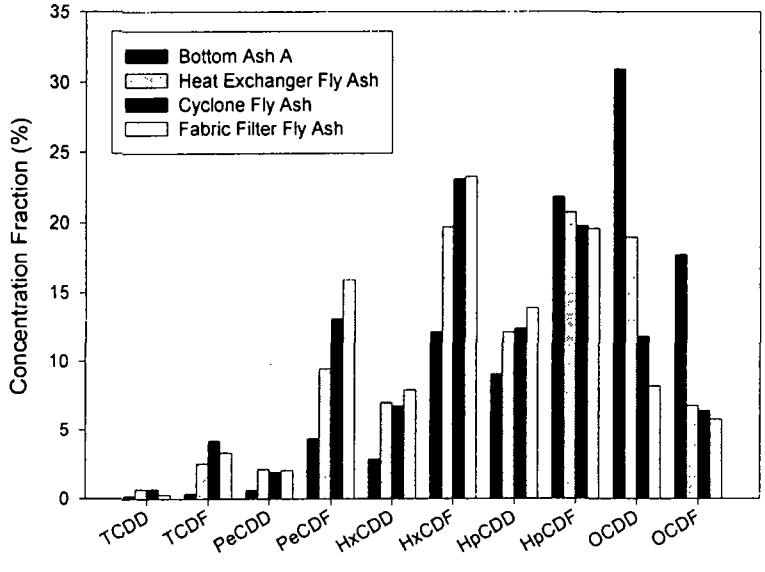

Fig. 2 Characteristic profile of PCDD/PCDFs homologue in ash samples

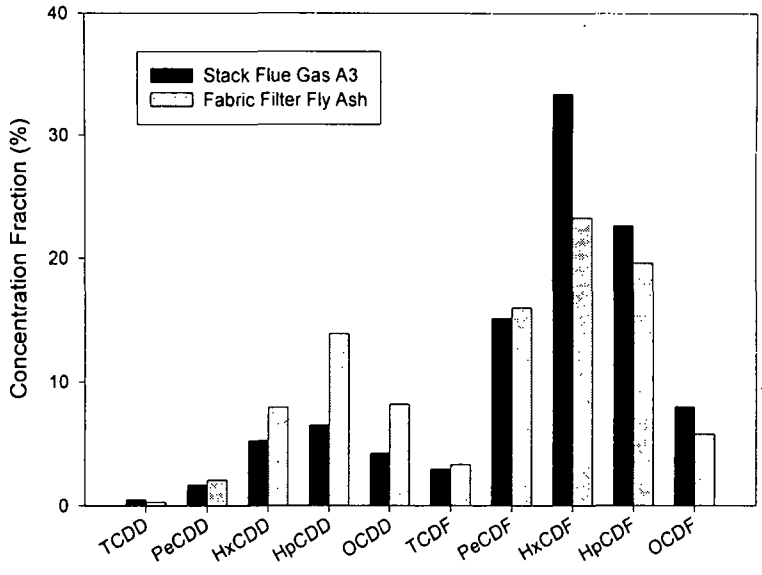

Fig. 3 PCDD/PCDFs homologue profiles of stack flue gas A3 and fabric filter fly ash

Reference

[1] Thornton, J., McCally, M.,and Orris, P., *Public Health Reports,* **1996**, 111, 298.
[1] G.. H. Eduljee, P. Dyke, *The Science of the Total Environment*, **1996**,177,303.
[1] Addink,R., Oile, K. *Environmental Science and Technology*, 1995, 6,1425.
[1] Buekens, A., Prakhar, P., Stieglitz, L. Jacobs, P., *Organohalogen Compounds*, **1999**,41, 97.