Analysis of dioxins in ambient air in the vicinity area of an incineration plant

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Abstract

Air samples were collected from five stations around a waste incinerator when dioxin-contained residues were combusted. High resolution gas chromatography-high resolution mass spectrometry (HRGC-HRMS) combined with sohxlet extraction and column chromatographic clean-up were applied for the trace analysis of PCDD/Fs in ambient air. Samples are spiked with a known amount of isotopically-labelled analytes. The relative response factor of the labelled analyte to the corresponding native analyte is used to quantify analyte concentration in samples.

Introduction

Polychlorinated dibenzo-p-dioxins and polychlorinated dibenzofuran (PCDD/Fs) may be unintentionally formed and released from combustion process and distributed widely in environment. PCDD/Fs could be transported over long distances when released into the air, transferring to soils, vegetation, water, biota, etc. PCDD/Fs emitted from an incinerator during the combustion of dioxin-contained residues are cause for concern in the adjacent population. For this reason, the ambient PCDD/Fs concentration is monitored in the vicinity area of the incineration plant.

Materials and Methods

(1) Sample collection, extraction and clean-up

Each ambient air sample was collected with quartz micro-fiber filter and poly urethane foam plug (PUF) complying with USEPA method.[1] Before sampling, surrogate standard ($^{37}Cl_4$-2,3,7,8-TCDD, $^{13}C_{12}$-2,3,4,7,8-PeCDF, $^{13}C_{12}$-1,2,3,4,7,8- HxCDD, $^{13}C_{12}$-1,2,3,4,7,8-HxCDF, $^{13}C_{12}$-2,3,4,6,7,8-HxCDF, $^{13}C_{12}$-1,2,3,4,7,8,9- HpCDF) was spiked at PUF. Once the sampling was completed, the sample was brought back to laboratory under refrigeration. Then USEPA Method 23[2] internal standard was spiked at the sample. Thereafter, the PUF and filter were soxhlet extracted with 300mL toluene for at least 16 hours. The toluene extract was then concentrated to approximately 1-2mL using rotary evaporator and was exchanged into hexane. After being treated with conc. sulfuric acid, the extract was subjected to a series of clean-up columns including sulfuric acid silica gel column, acidic alumina column as well as activated carbon/Celite column. The purified sample was spiked with Method 23 recovery standard for HRGC/HRMS analysis.

(2) HRGC/HRMS analysis

All the samples were analyzed by high-resolution GC-mass spectrometry using SIM mode with a

MicroMass Autospec Ultima HRMS equipped with a Hewlett-Packard 6890 GC system and a DB-5MS capillary column (60m x 0.25mm i.d.). The resolution of the mass spectrometer was set at 10,000. The GC temperature program was 170°C (held for 1.5 min), increased at 20°C/min to 220°C (held for 5 min), increased at 1°C/min to 240°C (held for 10 min), increased at 5°C/min to 300°C (held for 9 min). Injector temperature was 300°C and injection was made on splitless mode. Helium was used as carrier gas with flow rate 1mL/min.

Results and Discussion

The results of the ambient air dioxin monitoring during the trial, first, second and third incinerations, as well as the results of the baseline monitoring are summarized in Table 1. Location of those five sampling sites is given in Figure 1.

The average ambient air dioxin concentrations of the five sampling sites ranged from 0.034 to 0.055 pg TEQ/m^3 during the trial incineration exercise. These results were similar to those measured during the third incineration (0.041 to 0.057 pg TEQ/m^3), but lower than those obtained during the first incineration (0.090 to 0.126 pg TEQ/m^3). It could be observed that the average dioxin levels in the ambient air of the five sampling sites measured during those incineration exercises are comparable to the baseline ambient air dioxin levels measured for these sites from November 2003 to October 2004. There were no obvious difference in dioxin concentrations among the five sites. The results of the dioxin monitoring project showed that the incineration did not add extra dioxin loading to the environment of the vicinity area of the incineration plant.

Table 1 Results of ambient air dioxins monitoring.

Sampling location	PCDD/F TEQ concentration (pg TEQ/m^3) (corrected at 298K & 1atm)				
	Trial	First incineration[1]	Second incineration[2]	Third incineration[3]	Baseline ambient dioxin monitoring[4]
Site A	0.034	0.112	0.029	0.057	0.043
Site B	0.039	0.119	0.022	0.056	0.044
Site C	0.046	0.126	0.030	0.047	0.037
Site D	0.055	0.090	0.035	0.041	0.038
Site E	0.042	0.108	0.031	0.039	0.032

Note:
1. The average of dioxin level from two sampling dates in Jan.'05 during the first incineration exercise.
2. The average of dioxin level from two sampling dates in Feb.'05 during the second incineration exercise.
3. The average of dioxin level from two sampling dates in Mar.'05 during the third incineration exercise.
4. The average of dioxin level from the baseline monitoring exercise from Nov.'03 to Oct.'04.

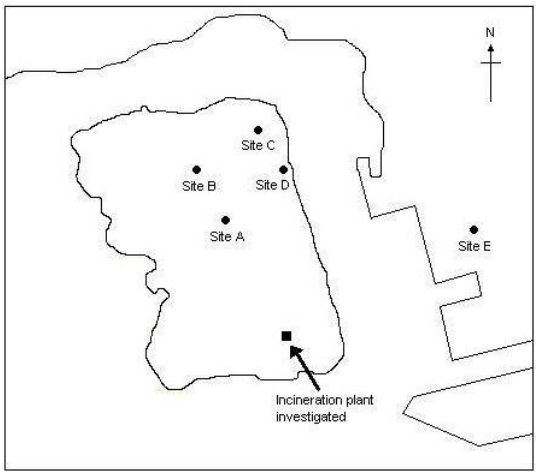

Figure 1 Location of sampling sites in the vicinity area of the incineration plant.

References

1. USEPA. *Compendium Method TO-9A. Determination of Polychlorinated, Polybrominated and Brominated/Chlorinated Dibenzo-p-Dioxins and Dibenzofurans in Ambient Air. Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air.* U.S. Environmental Protection Department. (1999).
2. USEPA. *Determination of Polychlorinated Dibenzo-p-Dioxins and Polychlorinated Dibenzofurans from Municipal Waste Combustors*, EPA Test Method 23. Code of Federal Regulations, Title 40, Part 60, Appendix A; U.S. Government Printing Office: Washington, DC, July 1991. (1991).