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VERTICAL DISTRIBUTION OF PCDD/Fs IN SOIL IN URBAN AREAS

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도시지역 토양에서 PCDD/Fs의 수직분포도 조사

미량물질분석팀

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초 록

생활폐기물소각장 배출가스로부터 발생된 다이옥신류는 대기를 거쳐 토양을 오염시키고, 오염된 토양은 직접 혹은 간접적으로 인체 건강에 영향을 미친다. 본 연구는 생활폐기물소각장 배출가스가 주변 토양의 다이옥신류 오염에 미치는 영향을 파악하고자, 생활폐기물소각장의 주변 토양의 깊이에 따른 다이옥신류의 농도를 동위원소희석방법에 따라 고분해능 질량분석기를 이용하여 측정하였다.

토양의 다이옥신류 농도는 등가독성농도로서 토양의 표면이 가장 높았고, 깊어짐으로서 낮은 농도를 보였다. 생활폐기물소각장 배출가스와 토양의 다이옥신류의 각 이성체의 상대 분포도를 비교한 결과 서로 상이한 분포도를 나타냈다.

주요어 : 생활폐기물 소각장, 다이옥신류, 동위원소희석방법

Introduction

Polychlorinated-dibenzodioxin(PCDDs) and polychlorinated dibenzofurans(PCDFs), here referred to collectively as dioxins, which is released into the soil environment, largely come from municipal solid waste incinerator(MSWI) due to incomplete combustion. The knowledge of these compounds fate and transport is essential in order to assess the potential impact on the environment. Because these compounds are semi-volatile and hydrophobic, they accumulate in organic rich media soil, sediment and biota.

In the environment, dioxins from incinerators result in dioxin release into soil and the contamination of human and food supplies tend to bio-accumulate in the food chain. Therefore, accurate information about the level of dioxin in soil is needed to assess the actual risk of exposure. With this information at hand, an assessment of the health impact can be performed and used as a basis for policy decision. In Seoul, however, there have been only a few reports concerning such analytical data.[1,2] Therefore, in this paper, we tried to reveal their real situation of existence condition in soil around the municipal waste incinerators in Seoul. One use for these data is to evaluate potential criteria for dioxin contamination in soil due to air pollution. This study, which was carried out in order to find the major factor in soil contamination, focused on vertical dioxins concentrations near the municipal waste incinerators in Seoul, Korea

Material and methods

The samples were taken from soil layers - the depth of which 10cm each -, using a specially cleaned stainless steel scoop in each other direction of east, west, south ad north locations within 1 km from the Yangcheon municipal waste incinerator in Seoul. The soil samples were extracted in toluene by ASE, cleaned-up by passage through a silica column and an alumina column. The fifteen $^{13}C_{12}$-labelled PCDD/Fs as to extraction standards were added to samples prior to extraction procedure and the two $^{13}C_{12}$-labelled PCDDs as to recovery standards were added to final volume prior to the analysis by HRGC/HRMS. The final volumes of Extracts are reduced to 20 ul using a gentle stream of nitrogen. Chromatograms were collected from Gas chromatography electron impact mass spectrometry (GC-EIMS, a Micromass Autospec Ultima) at a resolution of 15,000(10% valley) in SIM. Verification of the resolution in the working mass range was obtained by measuring perfluorokerosene(PFK) reference peaks. The current trap was 500uA, the ionization energy was 39eV and the acceleration voltage was 8000 V. Ion source temperature was 250℃. The two most abundant ions in the $[M-Cl]^+$ cluster were monitored at 60ms dwell time and a delay time of 20 ms. Chromaticgraphic separation was achived with a DB5-5ms(J&W Scientific, CA,USA) fused silica capillary column (60m DB-5ms 0.32mm i.d., 0.25um film thickness) with helium as carrier gas at a linear velocity of 35cm/s in the splitless injection mode of 1㎕. The temperature program was: 150℃ for 1min; 10℃/min to 210℃ hold for 8min, 3℃/min to 235℃ hold for 10min, 5℃/min to 310℃ hold for 3min. The measurement results were taken from chromatograms using OPUSquan software (Micromass Co.) The total I-TEQ concentration is calculated by the addition of the concentrations of the 17 individual 2,3,7,8-chlorine substituted PCDDs/DFs when multiplied by the appropriate I-TEF. All the results have been corrected according to the method blank but not recovery corrected.

Results and discussion

Dioxins were detected in every sample. A summary of dioxin results is presented in Table 1. The highest concentration were found in the upper layers of soils(0~10cm) with concentrations up to 4.525ng I-TEQ/kg d.m, which is much lower than the TEQ levels found in soil near the MSWI in the other country[3]. The lowest concentration was found in a depth lower than 30cm, which turned out to be 0.185ng I-TEQ/kg d.m. in all sites. This result indicates that the pollutants of atmosphere influenced the concentration in upper layer of the soil.

It was also pointed out that the concentrations decreased with increasing sampling depths. The disparity of the vertical concentration profile according to the depth is due to origin of soil, not site. Although review of the available literature

Table 1. Summary of PCDD/Fs isomer concentration according to the depth.

(Units :ng/kg)

		Isomer	1-10cm	10-20cm	20-30cm	〉30cm	Average
Furans	Tetra	2,3,7,8-TCDF	3.316	0.879	1.034	0.403	1.408
	Penta	1,2,3,7,8-PeCDF	2.794	0.862	0.917	0.298	1.218
		2,3,4,7,8-PeCDF	2.261	0.762	0.740	0.259	1.005
	Hexa	1,2,3,4,7,8-HxCDF	3.604	1.181	1.242	0.398	1.606
		1,2,3,6,7,8-HxCDF	2.792	0.913	1.030	0.371	1.276
		2,3,4,6,7,8-HxCDF	0.698	0.281	0.217	0.113	0.327
		1,2,3,7,8,9-HxCDF	2.968	1.103	1.018	0.409	1.374
	Hepta	1,2,3,4,6,7,8-HpCDF	14.755	5.982	5.795	3.053	7.396
		1,2,3,4,7,8,9-HpCDF	1.955	0.720	0.669	0.269	0.903
	Octa	OCDF	10.482	8.486	6.611	2.464	7.011
Dioxins	Tetra	2,3,7,8-TCDD	0.204	0.085	0.087	0.059	0.109
	Penta	1,2,3,7,8-PeCDD	0.837	0.332	0.389	0.170	0.432
	Hexa	1,2,3,4,7,8-HxCDD	0.715	0.300	0.375	0.177	0.392
		1,2,3,6,7,8-HxCDD	1.536	0.599	0.869	0.348	0.838
		1,2,3,7,8,9-HxCDD	1.137	0.507	0.661	0.402	0.677
	Hepta	1,2,3,4,6,7,8-HpCDD	13.811	6.260	9.711	3.872	8.414
	Octa	OCDD	149.543	78.780	98.108	73.163	99.898
		Total PCDFs	45.623	21.168	19,273	8.035	23.525
		Total PCDDs	167.782	86.862	110.199	78.1911	110.759

reveals a relative paucity of vertical data according to the depth, the vertical profile of dioxins found in the soil near the MSWI were comparable with results reported in studies from Austria,[4] Netherlands.[5]

The vertical profiles of concentration in the soil were similar to concentration pattern of Austria and Netherlands in decreasing of the concentration according to the depth. The concentration of upper layer were under the upper range of concentrations found in Austria and Netherlands but were similar to 3.05-20.79ng I-TEQ/kg from industrial area[2] and 0.25-7.03ng I-TEQ/kg from the vicinity of a paper mill[2] previously reported in Korea

Fig.1 shows the concentration profile of dioxins according to isomer in the surface soil around the MSWI and Fig.2 shows the concentration profiles in the effluent gas from the MSWI. As shown in these Figures, the highest concentration as to TEQ levels was found in 1,2,3,6,7,8-PCDF in the soil near the MSWI, and 2,3,4,7,8-PCDF in the emission source of the MSWI, respectively. Possibly the disparity of the concentration profile according to the isomer was pointed out that PCDD/PCDFs in the soil were due to the other source, not the effluent gas from the MSWI. Just based on this study, it is hard to conclude that MSWI is a major factor of soil contamination by PCDD/PCDFs. It seems some other source of air pollution, such as car emission, could have been a

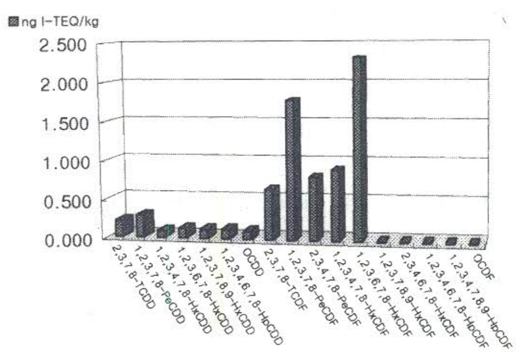

Fig. 1. Isomer profiles in soils near the MSWI.

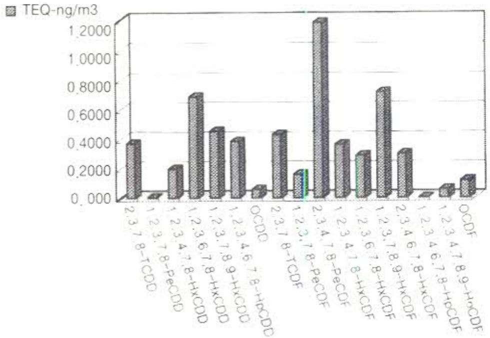

Fig. 2. Isomer profiles in the effluent gas from the waste incinerator.

major contamination factor.

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