The Characteristics of leaching of PCDDs/PCDFs in MSW landfill

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Introduction

Major sources of PCDDs/PCDFs detected in the landfill may be related to byproducts during the combustion and the thermal process of industrial and municipal waste. To determine if the wastes such as bottom and fly ash are deposited to a MSW sanitary landfill or not, TCLP tests are performed in Korea. But the TCLP is focused not on organic compounds but on inorganic compounds such as heavy metals (though TCLP includes some of organic compound such as PCBs) so that it is interesting to study the pathway and dynamics of Dioxin, one of the organic compounds, in the waste.

Most of the PCDDs and PCDFs have low solubility in the water. Especially the higher chlorinated PCDDs and PCDFs have the lower solubility than other lower chlorinated PCDDs and PCDF so that coefficients of the higher chlorinated PCDDs and PCDFs become higher than those of the lower chlorinated PCDDs and PCDFs. This experiment investigated the concentrations of PCDDs and PCDF for fly ash and bottom ash by the two kinds of extraction, L/L extraction after TCLP and soxhlet apparatus extraction, to survey leaching dynamics of incineration residues in the landfill. And the concentration of leachate from actual landfill was investigated.

PCDDs and PCDFs of fly ash and bottom ash extracted by L/L extraction after TCLP were not nearly detected. But by the soxhlet apparatus extraction, fly ash is 9.267ng/g; and bottom ash is 0.310ng/g. Leachate obtained from landfill is 0.621pg/L.

Material and Methods

Bottom ash and Fly ash were dried naturally, sieved with 2mm-size sieve. After the previous step, Those samples were extracted by different method, L/L extraction after TCLP and soxhlet apparatus extraction. In former method, L/L extraction after TCLP, samples were leached according to below TCLP condition as testing method to determine whether treated in the MSW landfill or not. The pHs of samples before leaching were 5.8 6.3, and then added distilled water for leaching to sample containers (sample : water(v/v) = 1:10), shaking containers by using shaker for 6hrs (rpm 200). The pHs of samples after leaching were 11.8-11.9.

And samples were filtered by GF/B and only filtrates were extracted by liquid-liquid extraction (methylene chloride as shown in the Table 2), and concentrated for cleanup steps. In latter method, samples were treated by 2N HCl solution, and filtered by GF/B. Solid on the GF/B filter was extracted in Dean-Stark soxhlet extraction (Toluene, 24hrs) and filtrate was extracted by liquid-liquid extraction like the method (1) TCLP-L/L. Extracts by both soxhlet and liquid-liquid were concentrated. Although samples were extracted by two different methods, all sample were purified by the same cleanup procedures which are sulfuric acid treatment for removing most of organic material, multilayer silicagel(Neural/Acidic44%/N/Basic30%N) column, and alumina column(basic, 70 230mesh). Especially, before alumina cleanup, leachate sample obtained from landfill was needed to have Cu column to remove sulfur component due to the anaerobic condition

Final extracts were analyzed with SP 2331 column (60mx0.32mmIDx0.23um) according to EPA 1613 method using HRGC/HRMS (Autospec Ultima, Micromass Co., UK).

Table 1. Overview of landfill investigated

Starting Year / Total amount	From 1992.9 / 65 million tons until now	
wastes landfilled	Municipal waste	53.6%
	Briquette of coal	0.7%
	Construction waste	21.3%
	Sewage sludge	9.5%
	Sewage dredged soil	3.3%
	Bottom ash, Fly ash, Waste water sludge	11.5%

Table 2. Experimental Procedures

< Bottom ash, Fly Ash >		< Leachate from Landfill >
Method : TCLP-L/L	Method : Soxhlet+L/L	
TCLP ↓ Leaching Solution ↓ Filtrated by GF/B ↓ L/L Extraction ↓ Extract ↓ Cleanup ↓ Analysis	HCl Treatment ↓ Filtration GF/B ↙ ↘ solid filtrate ↓ ↓ Soxhlet L/L ↘ ↙ Extract ↓ Cleanup ↓ Analysis	Filtration GF/B ↙ ↘ Filtrate Liquid ↓ ↓ Soxhlet L/L ↘ ↙ Extract ↓ Cleanup ↓ Analysis

Results and Discussion

As shown in the Table 3., the total concentrations of PCDDs and PCDFs of Fly ash, and bottom ash in the soxhlet extraction were 9.267ng/g, 0.310ng/g. The table 3, Fig 1 and 2 have shown that the higher chlorinated compounds have higher concentration. The concentration of fly ash was 300 times higher than that of bottom ash. But Dioxin concentrations of Fly ash and bottom ash by TCLP-L/L extraction with filtration by GF/B were not nearly detected. Therefore TCLP of solid waste need to improve to estimate influence of dioxin exposure to environmental. Dioxin concentration of leachate from landfill was 622pg/L. The isomer profile of leachate was very similar to that of incineration residues. Even though higher chlorinated compounds have higher octanol coefficient than lower chlorinated, leaching concentration was not affected because of perhaps coexisiting materials such as humic and fulvic-like which have aromatic functional.
Also as shown in the fig 2, the portion of PCDDs of the leachate has been increased in comparison with the fly ash.

Reference

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Table 3. Results of Concentration of PCDDs/PCDFs

	Soxhlet Test(*pg/g*)		Leaching Test(*pg/ *)		Leachate (*pg/ *)
	Fly Ash	Bottom Ash	Fly Ash	Bottom Ash	
2,3,7,8-TCDD	4.708	0.450	ND	ND	0.392
1,2,3,7,8-PeCDD	25.358	1.482	ND	ND	1.306
1,2,3,4,7,8-HxCDD	40.150	2.052	ND	ND	1.498
1,2,3,6,7,8-HxCDD	125.520	5.180	ND	ND	2.626
1,2,3,7,8,9-HxCDD	62.498	3.284	ND	ND	2.092
1,2,3,4,6,7,8-HpCDD	1501.038	49.110	ND	ND	50.250
OCDD	4267.260	122.188	ND	ND	501.770
2,3,7,8-TCDF	38.450	2.034	ND	ND	1.602
1,2,3,7,8-PeCDF	81.806	2.633	ND	ND	1.640
2,3,4,7,8-PeCDF	151.910	5.046	ND	ND	2.686
1,2,3,4,7,8-HxCDF	100.312	4.378	ND	ND	1.412
1,2,3,6,7,8-HxCDF	203.424	8.828	ND	ND	2.842
2,3,4,6,7,8-HxCDF	385.140	13.394	ND	ND	3.306
1,2,3,7,8,9-HxCDF	44.596	2.170	ND	ND	2.826
1,2,3,4,6,7,8-HpCDF	1032.934	53.558	0.839	ND	30.534
1,2,3,4,7,8,9-HpCDF	219.654	9.818	ND	ND	ND
OCDF	982.310	25.010	ND	ND	15.018
PCDD	6,026.532	183.746	0.000	0.000	61.866
PCDF	3,240.536	126.869	0.839	0.000	559.934
PCDD+ PCDF	9,267.068	310.615	0.839	0.000	621.800

Figure 1. Isomer's Profile of PCDD/PCDFs in the Fly Ash and Bottom Ash

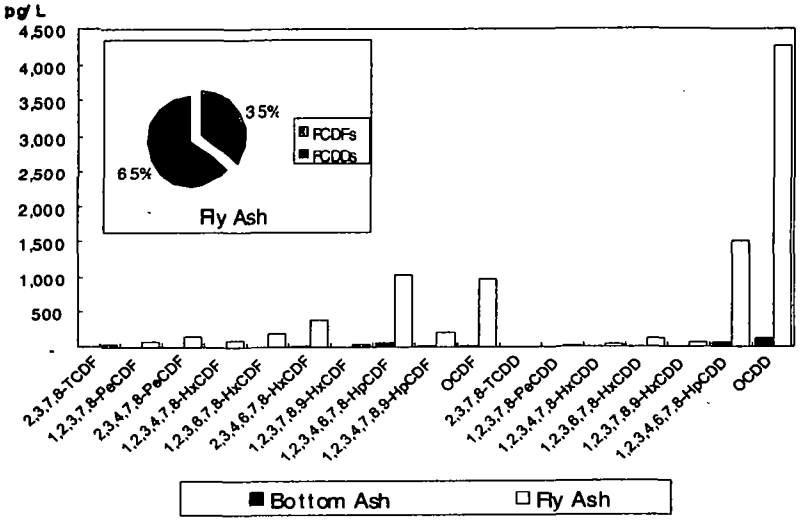

Figure 2. Concentration Profile for PCDD/Fs of Leachate from landfill

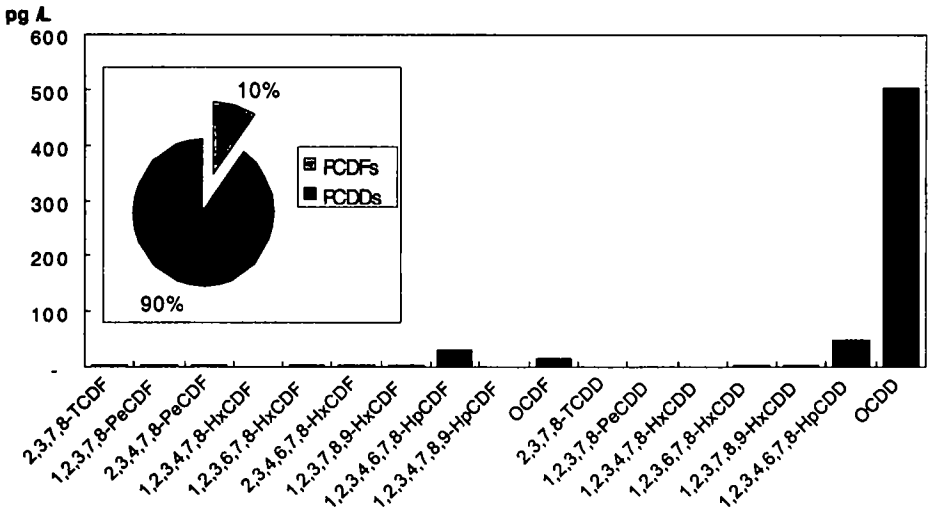

Figure 3. Concentration Ratio of between leachate (pg/L) and bottom ash, fly ash (pg/g)