BEHAVIOR OF DIOXINS IN TREATMENT PROCESSES FOR LANDFILL LEACHATES

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Introduction

Incinerator ashes from municipal solid waste (MSW) are landfilled in controlled-type disposal sites with leachate treatment. Dioxins released from disposal sites have been of concern as well as exhaust gas from MSW incinerators, because of landfilling of incinerator residues with high concentration of dioxins. Waste Disposal and Public Cleansing Law stipulates that effluent from final disposal sites contain no more than 10 pg-TEQ/L of dioxins, in Japan. According to the nationwide investigation of dioxins in leachates of MSW landfills, dioxins concentrations in raw leachates were below 1000 pg-TEQ/L, and in effluents were below 100 pg-TEQ/L[1]. Our previous study on the mass flow of dioxins in a landfill site disposed of MSW incinerator ashes revealed that dioxins had not been easily decomposed in disposal sites and would be persistent for a long time[2]. Under these circumstances, new technologies to remove dioxins from raw leachate, such as membrane filtration process and advanced oxidation process (combination of ultraviolet light, ozone, hydrogen peroxides and etc.) have recently been developed [3-6]. This report presents dioxins removal efficiencies (concentration and total amount) in different kinds of leachate treatment facilities of four landfills and the relationship between dioxins and other parameters such as SS, COD, BOD, TOC.

Materials and Methods

1) Outline of facilities and samples

Table 1 shows the outline of the facilities investigated. Treatment processes vary in capacity, biological treatment method, and activated carbon absorption system. The treated water was collected after predetermined residence time from each treatment process. In order to decrease the sampling error, each sample was prepared by mixing three samples collected 3 times after an interval of thirty minutes in the same sampling point. Twenty liters of water samples were used for analysis.

2) Analysis

Samples were filtered by glass fiber filter with pore size of 1 μm. The filtrate was extracted by shaking with dichloromethane, treated with conc. sulfuric acid, and then cleaned up with silicagel column chromatography and alumina column chromatography. The suspend solids (SS) were treated with 1M hydrochloric acid and extracted by toluene soxlet extraction. Determination was made using capillary column gas chromatography connected to a high-resolution mass spectrometer. Columns of SP-2331 (0.32 mm, 60 m) and DB-5 (0.25 mm, 30 m) were used respectively for tetra-, penta-, hexa-CDDs/CDFs, and for hepta- , octa-CDDs/CDFs and Coplanar

PCBs.

Table 1. Outline of Facilities

No.	Treatment Capacity (m^3/day)	Treatment Process						
		Primary Coagulation (P.C.)	Biological Denitrification(B.D.)			Secondary Coagulation (S.C.)	Sand Filter (S.F)	Activated Carbon Absorption (A.C.)
			Activated Sludge	Contact Oxidation	Rotating Plate			
1	85			○		○	○	
2	70				○	○	○	○
3	72	○		○		○	○	○
4	400		○	○		○	○	

Results and Discussion

1) Removal characteristics of dioxins for each water treatment process

Figure 1 and Table 2 show the concentrations of dioxins for each leachate treatment process. Comparing with raw leachates and effluents, dioxins concentrations ranged from 2.1 to 130 pg-TEQ/L in raw leachates, while those ranged from 0.0067 to 1.1 pg-TEQ/L in final effluents. Removal rates after total treatment process were nearly 100%.

Removal rate of coagulating sedimentation process was 28% to 99%. In the facility with high removal efficiency, concentrations of dioxins in suspended solids were relatively high. It seemed that dioxins contained in or absorbed to suspended solids were removed through coagulating sedimentation process. Removal rate of sand filtration and activated carbon absorption treatment process were 33% to 94%. In biological process, dioxins removal was observed in two facilities (No.2, 4). However in the facility No.1 dioxins concentration after biological process increased. The reason might be a contamination of biological sludge as suspended solids that contain dioxins.

Table 2. Dioxins Concentrations from Leachate Treatment Processes

No.	Samples	pH	BOD (mg/L)	COD (mg/L)	SS (mg/L)	T-N (mg/L)	Cl⁻ (mg/L)	DXNs (pg-TEQ/L)		
								SS	non-SS	Total
1	B.D. influent	7.9	28.6	78.6	96.8	64.4	3700	91	43	130
	B.D. effluent	7.6	30.3	55.2	137	11.2	3190	160	73	230
	S.C. effluent	7.0	4.8	31.9	1.9	6.7	3200	0.18	1.6	1.8
	S.F. effluent	7.4	1.8	30.5	0.3	6.4	3200	0.0015	1.1	1.1
2	B.D. influent	7.9	9.5	6.3	4.7	16.7	8950	0.98	1.4	2.4
	B.D. effluent	7.6	0.61	3.3	1.1	16.2	8680	0.014	0.21	0.22
	S.C. effluent	7.6	5.4	3.7	1.3	16.1	8650	0.071	0.049	0.12
	A.C. effluent	7.0	5.4	4.9	0.4	14.9	8630	N.D.	0.0067	0.0067
3	P.C. influent	8.3	97.7	45.3	38.1	43.0	4560	1.7	0.32	2.1
	P.C. effluent	9.5	67.8	34.9	11.3	40.2	4540	0.0077	0.010	0.018
	B.D. effluent	7.0	22.9	23.9	32.8	16.1	4040	0.012	0.013	0.025
	S.C. effluent	6.9	37.4	19.0	5.6	21.9	3810	0.0066	0.011	0.018
	A.C. effluent	6.0	6.4	5.3	1.4	12.0	3970	0.0062	0.0055	0.012
4	B.D. influent	8.2	543	433	159	308	2510	29	0.25	29
	B.D. effluent	8.3	58.5	166	129	17.4	2260	16	0.0076	16
	S.C. effluent	8.2	17.0	133	7.8	14.0	2260	1.5	0.0074	1.5
	S.F. effluent	8.3	10.9	34.5	3.6	14.0	2200	0.84	0.0095	0.84

SS = Dioxins concentration in SS
non-SS = Dioxins concentration in filtrate
B.D. = Biological Denitrification
S.C. = Secondary Coagulation
S.F. = Sand Filter
A.C. = Activated Carbon Absorption
P.C. = Primary Coagulation

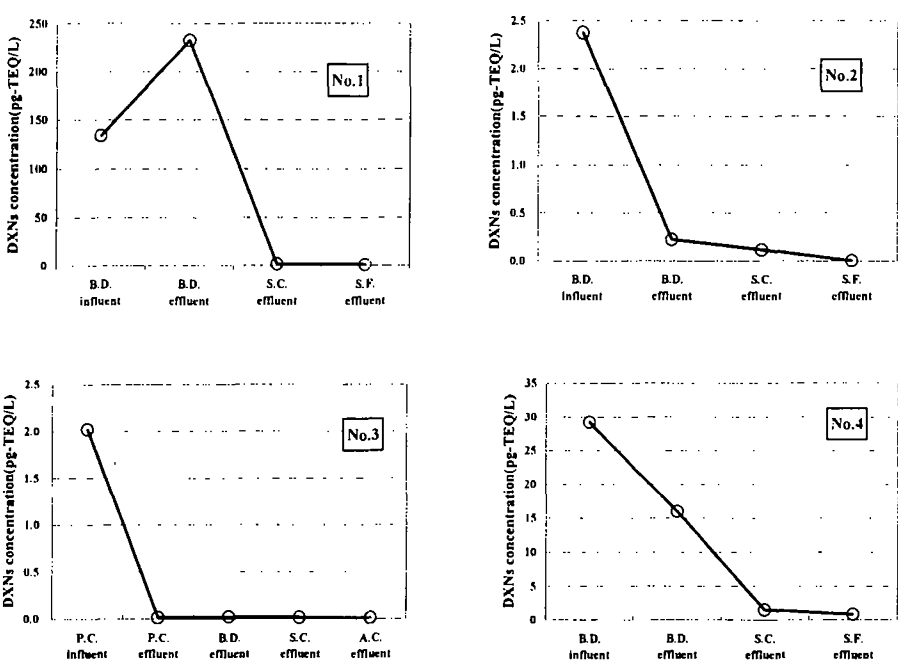

Figure 1. Dioxins concentrations of Leachate Treatment Processes

2) Concentration of dioxins in the sludge from water

Total amount of dioxins removed by leachate treatment processes calculated for Facility No.3 was 143,136 pg-TEQ/day, while that accumulated in the sludge generated by the treatment process was estimated at 144,000 pg-TEQ/day. As two estimated amounts were almost equal, it can be concluded that dioxins removed from raw leachates concentrated into the sludge by the treatment process. It is noticed that sludge containing high concentration of dioxins should be managed properly.

3) Relationship between dioxins and other parameters

Figure 2 shows the relationship between concentrations of dioxins and SS, COD, BOD, TOC. Between SS and dioxins there exists weak positive correlation in each facility except for No.3. Dioxins concentrations showed the tendency of similar decrease for COD at No.4, for BOD at No.1 and 4, and for TOC at No. 4. But dioxins decreased more rapidly than these organic parameters in leachate treatment processes shown in Table 2. These results indicate that the parameter SS might be used as a substituting indicator for checking of dioxins concentration.

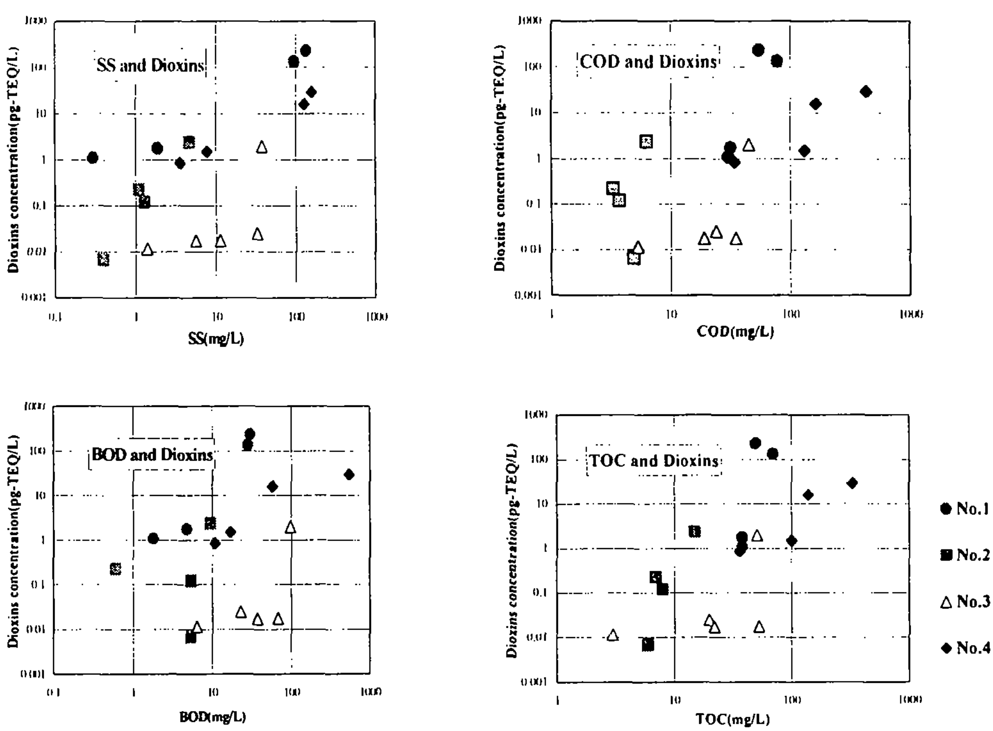

Figure 2. Relationship between Dioxins and SS, COD, BOD, TOC

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