DIOXINS EMISSION FROM THE INDUSTRIAL WASTE INCINERATION IN JAPAN IN 1999

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Introduction

The total emission of dioxins (DXN=PCDD/PCDF+Co-PCB) in Japan is estimated in the range of 2,620~2,820g-TEQ/y in 1999, and that from combustion facilities for industrial wastes is estimated 690g-TEQ/y which is 25% of the total[1]. A lot of data have been gathered concerning with dioxin emission control from municipal solid waste. But we have a little data on the industrial waste, because a wide variety of industrial waste is incinerated, and also there are numerous types and sizes among the furnaces[2]. In this research, nationwide DXN emission was estimated for industrial waste based on the available questionnaire[3] survey results done by Ministry of Health and Welfare in 1999, on industrial waste incinerator including DXN measurement data.

Methods

Questionnaire[3] survey included information on 1) kind of waste, 2) capacity of incinerator, 3) combustor, 4) gas cooling, 5) dust removal, etc. The industrial waste incinerators are classified into two types namely mono-type waste incinerator and mixed waste incinerator (Fig. 1). Only one kind of waste is incinerated in the mono-type incinerator whereas more than one kind of waste is incinerated in mixed waste incinerator. The emission factor is calculated using the following equation.

$$EF = \frac{\sum^{N}(C \times F_V)}{\sum^{N} I_W}$$

Table 1. Flue gas volume per waste[4]

Wastes	G (m^3N/kg)
Waste wood*	7.0
Waste plastics	14.5
Waste oil	10.5
Sludge	2.0
Infectious waste	14.5

* Including demolition waste wood

Where: EF = Emission Factor (average ng-TEQ per kg of waste burned)
N = Number of incinerators
C = DXN concentration in emission gases (ng-TEQ/m^3N)(adjusted to 12% O_2)
F_V = Volumetric flue gas flow rates, $F_v = G \cdot I_w$ (m^3N/y) (adjusted to 12% O_2)
G = Flue gas volume per kg of waste burned (m^3N/kg) (adjusted to 12% O_2, Table 1.)
I_W = Average waste incineration rates (kg/y)

Results and Discussion

Table 2 shows the DXN concentration of mono-type and mixed waste incinerator were classified into 1) combustor, 2) gas cooling, and 3) dust removal. And Fig.1 shows the classification of incinerators. For all industrial waste incinerators (n=2,930), average nationwide DXN concentration was 7.1ng-TEQ/m^3N.

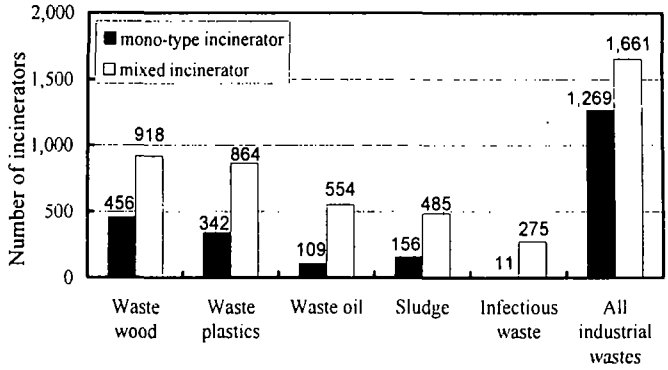

Fig. 1. Number of industrial incinerators

Table 2. Numbers and average DXN concentration of industrial waste incinerators

Equipment	Type	Industrial wastes burned											
		Waste wood *		Waste plastics *		Waste oil *		Sludge *		Infectious waste *		All industrial wastes	
		N	C	N	C	N	C	N	C	N	C	N	C
Combustor	Fixed bed furnace	1,106	11	778	7.7	264	7.6	190	9.2	173	14	1,938	8.9
	Rotary kiln	55	4.6	91	4.2	107	3.9	186	2.7	26	5.4	227	3.0
	Stoker furnace	53	7.0	50	5.6	25	6.3	31	4.5	15	4.2	98	5.1
	Gasification furnace	63	7.7	125	5.1	36	7.7	23	6.4	30	11	159	5.5
	Others	97	7.5	162	4.7	231	3.5	211	3.5	42	7.7	508	3.1
Gas cooling	Furnace separation water spray	172	8.0	170	6.8	168	4.3	162	4.4	87	8.7	366	5.3
	Furnace top water spray	48	14	34	12	26	9.9	20	12	16	12	89	9.2
	Boiler	66	11	113	4.4	63	2.6	69	2.1	10	14	231	5.3
	Without gas cooling	1,011	11	775	6.8	277	7.3	288	6.0	138	13	1,972	8.0
	Others	77	10	114	6.3	129	3.8	102	4.7	35	12	272	4.2
Dust removal	Cyclone separator	844	11	520	7.0	120	7.8	148	5.6	62	13	1,457	8.8
	Scrubber	55	8.2	55	7.0	75	2.7	35	2.1	21	11	188	4.1
	Bag filter	39	3.3	70	3.2	43	2.8	54	2.1	30	4.2	117	2.9
	Without dust removal	104	6.9	161	3.2	60	2.0	25	5.6	26	7.3	342	4.0
	Others	332	11	400	8.2	365	6.2	379	5.6	147	13	826	6.8
All industrial waste incinerators		1,374	10	1,206	6.7	663	5.5	641	5.1	286	12	2,930	7.1

N: Number of incinerators, C: Average concentration of DXN (ng-TEQ/m^3N) (adjusted to 12% O_2)

* Not only mono-type waste but also including mixed waste.

The most common combustor is a fixed bed furnace (n=1,938, 66.1%). And most incinerators are without any gas cooling equipment (n=1,972, 67.3%). Further, the most common dust removal is using cyclone separator (n=1,457, 49.7%).

In the fixed bed furnace for all wastes, DXN concentration was higher than that of other furnace. DXN concentration for fixed bed furnace was 8.9ng-TEQ/m^3N. In terms of gas cooling, furnace top water spray and without gas cooling equipment for which DXN concentrations were 9.2ng-TEQ/m^3N and 8.0ng-TEQ/m^3N, respectively emitted high DXN concentration compared to other equipment. In case of dust removal, cyclone separator for which DXN concentration was 8.8ng-TEQ/m^3N emitted the highest DXN concentration with other equipment.

Nationwide DXN concentration of mono-type industrial waste incinerators and all industrial wastes are shown in Table 3 and Fig. 2. DXN concentration for each waste in decreasing order is as follows; waste wood, infectious waste, waste plastics, sludge, and waste oil. For all industrial waste incinerators, nationwide emission factor was 25ng-TEQ/kg (Table 3). Emission factors for each waste are also shown in Table 3 including mono-type industrial waste and all industrial waste. Emission factor for each waste in decreasing order is as follows; infectious waste, waste wood, waste plastics, waste oil, and sludge.

Table 3. Average DXN concentration and emission factor of industrial waste incinerators

Wastes		This research					References		
		N	C (ng-TEQ/m^3N)			EF	C	EF	Author
			Ave.	Med.	Max.	(ng-TEQ/kg)	(ng-TEQ/m^3N)	(ng-TEQ/kg)	
Mono-type industrial wastes	Waste wood	456	11	3.8	78	76	---	---	
	Waste plastics	342	4.2	0.6	69	39	---	---	
	Waste oil	109	0.8	0.1	39	6.3	0.1～0.3	4	Bremmer et al. [5]
	Sludge	156	1.1	0.2	33	1.1	---	2.75～28.0	Bremmer et al. [5] Cains et al [6]
	Infectious waste	11	8.1	4.8	40	100	---	7～1,860	Doucet [7]
All industrial wastes		2,930	7.1	1.4	440	25	---	---	

For waste wood, nationwide DXN concentration was 11ng-TEQ/m^3N, and the emission factor was 76ng-TEQ/kg.

For waste plastics, nationwide DXN concentration was 4.2ng-TEQ/m^3N, and the emission factor was 39ng-TEQ/kg.

For waste oil, nationwide DXN concentration was 0.8ng-TEQ/m^3N, and the emission factor was 6.3ng-TEQ/kg. Bremmer et al.[5] reported in 1994 that DXN concentration was in the range of 0.1 ～ 0.3ng-TEQ/m^3N and the

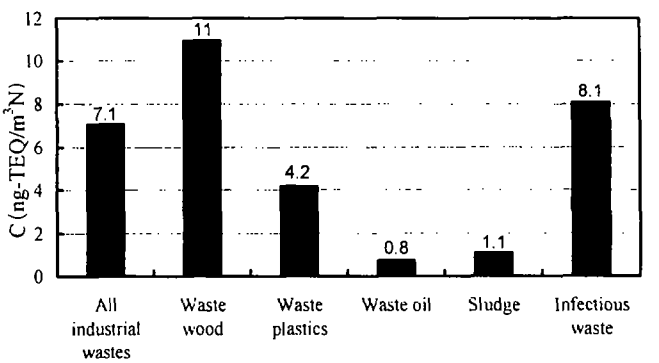

Fig. 2. Average DXN concentration of industrial incinerators

average emission factor was 4ng-TEQ/kg.

For sludge, nationwide DXN concentration was 1.1ng-TEQ/m^3N, and the emission factor was 1.1ng-TEQ/kg. Bremmer et al.[5] reported that the emission factor of the sewage sludge incinerator with cyclone separator and wet scrubber was 5ng-TEQ/kg in the Netherlands. Cains[6] studied on British sewage sludge incinerator in 1994 and reported that the emission factor was 2.75~28.0ng-TEQ/kg for the incinerator with electrostatic precipitator and wet scrubber. Both of these reported values are greater than nationwide DXN concentration in Japan.

For infectious waste, nationwide DXN concentration was 8.1ng-TEQ/m^3N, and the emission factor was 100ng-TEQ/kg. Doucet[7] reported in 1995 that the emission factor was 1,700~1,860ng-TEQ/kg on the medical waste incinerator without emission gas treatment and 7~1,350ng-TEQ/kg with emission gas treatment. The lowest emission factor was 7ng-TEQ/kg for the case of incinerator controlled by dry sorbent injection/fabric filter.

Conclusion

(1) DXN emission

For all industrial waste incinerators, average DXN concentration was 7.1ng-TEQ/m^3N, emissions were 690g-TEQ/y, and average emission factor was 25ng-TEQ/kg in Japan in 1999.

(2) DXN concentration

Nationwide average DXN concentration of mono-type waste incinerator for waste wood, infectious waste, waste plastics, sludge, waste oil, was 11ng-TEQ/m^3N, 8.1ng-TEQ/m^3N, 4.2ng-TEQ/m^3N, 1.1ng-TEQ/m^3N, 0.8ng-TEQ/m^3N, respectively.

(3) Emission factor

Nationwide average emission factor of mono-type waste incinerator for infectious waste, waste wood, waste plastics, waste oil, sludge, was 100ng-TEQ/kg, 76ng-TEQ/kg, 39ng-TEQ/kg, 6.3ng-TEQ/kg, 1.1ng-TEQ/kg, respectively.

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