Emission of PCNs from Municipal Waste Incineration Plant

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Introduction

Recently, much attention is paid to organochlorine chemical compounds and among them, especially on organochlorine agricultural pesticides and dioxin, PCBs etc., a lot of studies are reported to have been conducted. However, regarding researches on PCNs, while data concerning material analysis are partially reported, findings in conjunction with steel and aluminum refinery of incineration plant are still inadequate[1,2,3,4].

PCNs have total 75 isomers ranging from mono to octa depending on the number of chlorines substituted into compounds with naphthalene. Some of them are reported to have toxicity similar to dioxin and especially, compounds substitute chlorine in the locations of 2, 3, 6 and 7 are reported to have high toxic qualities[4]. In addition, Blankenship et al informed that TEF in PCNs is approximately from 0.0000035(57) to 0.004(66) [5].

PCNs are generated in the environment mainly because of the following three sources. 1) Industrial PCNs compounds, which are produced for the use of insulators in transformers. 2) Some PCNs are present as impurities in the production process of PCBs and discharged in the open air. 3) They are also generated through incineration. Like dioxin, many PCNs are reported to be emitted during the incineration and metal refinement[4].

This paper examined the level of concentration discharged from the incineration plant as well as the behavior of PCNs in each process in the facilities, which are one of the main generation sources.

Material and Methods

Subject facilities are a stocker-type incinerator operating around the clock and the process is conducted with gas cooler, electronic precipitator, wet scrubber, bag filter etc. Samples are taken in boiler inlet, boiler outlet, electronic precipitator inlet, electronic precipitator outlet, wet scrubber outlet, bag filter inlet, and stack.

Samples are divided into gaseous and particulate phase and are extracted by toluene in soxhlet.

Extracted samples are turned into a concentrated solvent and after then, refined into multi-layer silica-gel column and concentrated as analysis samples.

For the analysis of PCNs, HRGC/HRMS(Jeol 700) is used and analysis column is DB-5MS(60m*0.32mm*0.25um)column. 13C-PCBs is used as interior standard material and recovery rate is good as over 90%. TEF applied to this paper is WHO-TEF for PCDD/Fs and to PCNs, TEF published by Blankenship et al and Veilleneuve et all is applied[5,6].

Results and Discussion

This paper takes Tri-Octa homologue among PCN mono-octa as its analytic subject and PCN concentration at each sample-taking location is shown in Table 1.

Total concentration changes at each sample-taking location showed that the highest concentration was at 199.132ng/m^3 in boiler inlet, and others were examined respectively at 33.201ng/m^3 in wet scrubber outlet, 28.532ng/m^3 in EP outlet, 20.561ng/m^3 in boiler outlet, 19.856ng/m^3 in bag filter inlet, 7.612ng/m^3 in EP inlet, 0.512ng/m^3 in stack.

TEQ concentration levels were investigated as 34.340 pg-TEQ/m^3 in boiler inlet, 10.241pg-TEQ/m^3 in wet scrubber outlet, 7.954pg-TEQ/m^3 in boiler outlet, 7.446pg-TEQ/m^3 in EP outlet, 4.184pg-TEQ/m^3 in bag filter inlet, 1.368pg-TEQ/m^3 in EP inlet, and 0.126pg/m^3 in stack.

Regarding total concentration, changes in each sampling location showed a great difference, especially in both boiler inlet and outlet. These results are thought to be related to the fact that concentration increases in inlet due to the unburned combustibles generated in the incineration process, but is reduced by fly ash and the like during the passage of exhaust heat boiler through absorption within the boiler.

In case of EP, contrary to exhaust heat boiler, outlet concentration increases. This is because the operation temperature in EP is 200℃ and PCNs is synthesized again even though fly ash is removed within the electronic precipitator.

The decrease of PCN concentration discharged in stack before and after bag filter is regarded as the result of re -synthesization control by way of low temperature precipitation within the bag filter and absorption removal through active carbon input. Besides, the concentration of fl ash is found highest in bag filter. It is thought than because gaseous PCNs compounds are absorbed and removed, the concentration is

lowered.

Concentration changes at each sampling location are found to be almost the same pattern compared to those of PCDD/Fs. According to th research of Lee et al, the generation process of PCNs and PCDD/Fs in the incinerator is reported to be very similar[7].

In total concentration, the amount of PCNs emission in stack is 0.512 ng/Nm^3 and it takes 18% of PCDD/Fs.

Table 1 Concentration levels of PCNs, PCDD/Fs, PCBs in MSW

			Boiler inlet	Boiler outlet	EP inlet	EP outlet	WS outlet	BF inlet	Stack	Boiler outlet ash	EP outlet ash	Bag filter ash	Fly ash	Bottom ash
	T3CNs		34.472	3.082	1.790	5.214	3.796	4.049	0.100	0.037	0.909	23.584	0.110	0.026
	T4CNs		84.053	6.817	2.847	9.510	10.568	6.764	0.171	0.119	2.444	43.286	0.375	0.026
	P5CNs		55.165	5.744	1.987	8.074	10.981	5.765	0.153	0.159	2.482	30.766	0.430	0.009
	H6CNs		21.523	3.635	0.821	4.379	6.093	2.595	0.066	0.116	1.248	11.906	0.277	0.002
	H7CNs		3.638	1.161	0.156	1.243	1.614	0.628	0.018	0.028	0.442	3.292	0.108	N.D.
	O8CNs		0.282	0.122	0.009	0.113	0.149	0.054	0.004	0.002	0.046	0.739	0.009	N.D.
Total	PCN	ng/Nm^3 (ash ; ng/g)	199.132	20.561	7.612	28.532	33.201	19.856	0.512	0.460	7.570	113.572	1.310	0.063
	PCDDs/Fs	ng/Nm^3 (ash ; ng/g)	812.864	122.57	81.081	103.006	128.496	122.065	2.852	4.550	82.886	169.667	24.952	0.216
TEQ	PCN	pg/Nm^3 (ash ; pg/g)	34.34	7.954	1.368	7.446	10.242	4.184	0.126	0.221	2.423	18.663	0.567	0.003
	PCDDs/Fs	pg/Nm^3 (ash ; pg/g)	24953.40	2460.92	714	59.55	219	55.25	62.55	306.42	845.20	142.48	910	12.25	727	90.25	23	39.69	4	55.02
	PCBs	pg/Nm^3 (ash ; pg/g)	116.407	97.012	28.797	95.885	134.111	93.731	4.045	6.779	26.850	760.473	5.964	0.088

In the case of fly ash, compared to PCDD/Fs, the concentration level is 43.6%, half the level of PCDD/Fs. That of bottom ash is shown 29.1%.

In the concentration level of TEQ, mainly that of PCDD/Fs is dominant over all the other compounds, the concentration level is 0.3% in stack and in PCBs, it is 8.9%. In the case of fly ash, PCNs is 0.5% and PCBs is 19.1%.

From the viewpoint of toxicity of human body, the concentration rate of TEQ seems to be very low. But, the findings on the toxicity of PCNs are reported by only a few researchers and overall evaluation of the toxicity of PCNs is seldom made up to now.

Therefore, it is thought that further studies in this field should be necessary. Moreover, the incineration plant presumed to be one of the sources of PCNs and it is necessary investigate to the other sources much more than now[4,5,6].

Referance

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