Removal Efficiency of PCDDs/PCDFs by Air Pollution Control Devices in Municipal Solid Waste Incinerators

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Introduction

Korean government has turned around waste management policy to incineration from landfill by planning to construct the further commercial-scale MSW incinerators and to run the total of 53 facilities till 2001, including 9 facilities existed. All of these commercial-scale MSW incinerators were designed by foreign companies in the early of 1990, and started to run from the middle of 1990. The two thirds of nine MSW incineration facilities were equipped with EP(Electrostatic Precipitator) and WS(Wet Scrubber) to control the conventional air pollutants such as dust and acid gases rather than the dioxins/furans. But these kinds of APCDs, which were known to easily reform the dioxins/furans, has resulted in social dioxin problem. Therefore, this study was carried out to examine the removal efficiencies of dioxins/furans by APCDs(air pollution control devices), equipped to the commercial-scale MSW Incinerators with the capacity of above 200ton/day, and thus to provide the engineering data for the reduction of dioxins/furans and to lead the installation of proper APCDs suitable to our situation.

Material and Methods

The Korean Standard Testing Method for Dioxins and Furans was used to collect and analyze the sample. The three times samplings of PCDDs/PCDFs on each incineration sites were performed at the inlet and the outlets of APCD simultaneously. PCDDs/PCDFs was analyzed by HRGC/HRMS(High Resolution Gas Chromatograph/High Resolution Mass Spectrometer:

Micromass Co., Autospec Ultima) above 10,000 resolution with 60m x 0.32mmID x 0.25um of SP-2331. TEQ(Toxic Equivalents as 2,3,7,8-TeCDD) values are evaluated by using I-TEF (International-Toxicity Equivalency Factor)

Results and Discussion

As shown in Table 1, the two thirds of nine MSW incineration facilities designed in the early of 1990, were equipped with EP and WS to control the air pollutants. But in these days most of newly-installed MSW incineration facilities adopt SNCR-SDA/BF or SDA/BF-SCR as the combination of air pollutant control systems for the control of dioxis/furans with the rapid cooling of flue gas at the WHB.

Table 1. Installation Status of MSW Incinerators (1997)

Incinerator	Capacity (ton/day)	Process	Installed Year
IS	300	CC→WHB→EP→SCR→WS(NaOH)→Stack	Nov. `95
PC	200	CC→WHB→SDA→BF→Stack	Dec. `93
JD	200	CC→WHB→EP→WS(NaOH)→Stack	May. `95
MD	400	CC→WHB→SDA→BF(Lime/AC)→RH→SCR→Stack	Feb. `96
SK	800	CC→WHB→EP→WS(2 step)→RH→SCR→Stack	Jan. `97
SS	200	CC→WHB→EP→WS(2 step, NaOH)→Stack	Nov. `92
CW	200	CC(SNCR)→WHB→SDA(Lime/AC)→BF→Stack	Feb. `95
DD	200	CC→WHB→EP→WS(2 step)→Stack	Aug. `95
HWD	400	CC→WHB→EP→WS(NaOH)→RH→SCR→Stack	Sep. `96
Total	2,900		

Note: CC: Combustion Chamber, WHB: Waste Heat Boiler, EP: Electrostatic Precipitator, WS: Wet Scrubber, SDA: Spray Dry Absorber, BF: Bag Filter, AC: Activated Carbon, SCR: Selective Catalytic Reduction, SNCR: Selective Non-Catalytic Reduction.

As shown in Table 2, the RE(removal efficiencies) of PCDFs/PCDDs were represented up to 95% when the activated carbon was injected in front of EP, while PCDFs/PCDDs were synthesized in EP when not injected. Therefore, it might be efficient to spray the activated carbon in front of EP or to reduce the inlet temperature of EP to a temperature of less than 200℃ in order to prohibit the re-synthesis of PCDFs/PCDDs. SDA/BF represented to have the best removal efficiency of 99% to PCDFs/PCDDs when the mixed lime and activated carbon was sprayed into the SDA. As shown in Table 4, the whole congeners of PCDFs/PCDDs were enriched in WS by representing the removal efficiencies of -25% to -5,731% when the activated carbon was not added in scrubbing solution, while PCDFs/PCDDs were tended to be decreased with increasing the proportions of AC added in scrubbing solution. From these facts the enrichments of PCDDs/PCDFs in WS might be resulted that the relatively low level of PCDFs/PCDDs in flue gas was affected by scrubbing solution circulated, which contained as high as 30ng-TEQ/L of PCDFs/PCDDs, and the other packed or inside coating materials such as polypropylene, polyethylene and rubber. SCR system was probed to have the removal efficiencies to whole congeners of tetra- to octa-CDFs/CDDs, and the oxidative SCR represented the better removal efficiencies with the operating temperature of SCR decreased.

Table 2. Removal Efficiency of PCDDs/PCDFs by Electrostatic Precipitator

Incinerator	Inlet Temp.(℃)	PCDDs/DFs(ng-TEQ/N㎥)		RE(%)	AC injection
		Inlet	Outlet		
DD	155	1.892	0.613	67.6	Yes*
SK	200	5.732	0.819	85.7	No
JD	219	1.701	0.078	95.4	Yes*
SS	243	4.713	1.346	71.4	Yes*
HWD	225	1.183	2.524	-113.3	No
IS	271	2.771	3.991	-44.0	No
Mean		2.999	1.562	47.9	

* : in front of EP

Table 3. Removal Efficiency of PCDDs/PCDFs by SDA/BF

Incinerators	Inlet Temp.(℃)	PCDDs/DFs(ng-TEQ/N㎥)		RE(%)	Remarks
		Inlet	Outlet		
MD	140	2.894	0.033	98.9	Spray lime mixed with AC(3□5kg/hr)
PC	160	29.610	0.434	98.5	Spray lime and AC(2.5□5kg/hr),
CW	160	1.232	0.029	97.7	Spray Sorbalit (40□60kg/hr)
Mean		11.245	0.165	98.5	

Table 4. Removal Efficiency of PCDDs/PCDFs by WS

Incinerator	PCDDs/DFs(ng-TEQ/Nm^3)		RE(%)	Remarks
	Inlet	Outlet		
JD	0.078	4.548	-5,730.8	No use of AC in scrubbing water.
DD(1st)	0.292	0.364	-24.7	
HWD	2.524	3.326	-31.8	
SK	0.819	1.211	-47.9	
IS	0.459	0.820	-78.6	
DD(2nd)	0.458	0.616	-34.5	
Mean	0.772	1.814	-135.0	
SS	1.346	1.942	-44.3	4,000ppm of AC
DD(3rd)	0.665	0.216	67.5	14,300ppm of AC
	0.639	0.112	82.5	18,300ppm of AC
Mean	0.883	0.757	14.3	in scrubbing water
Total Mean	0.809	1.462	-80.7	

Note: JD, SS and SK used Packed Tower type of WS, while the others used Spray Tower type of WS.

Table 5. Removal Efficiency of PCDDs/PCDFs by WS

Incinerator	Operating Temp.(℃)	PCDDs/PCDFs(ng-TEQ/Nm^3)		RE(%)	Remarks
		Inlet	Outlet		
HWD	311	3.326	0.359	89.2	$TiO_2/V_2O_5/WO_3$(2 step)
SK	309	1.211	0.088	92.7	$TiO_2/V_2O_5/WO_3$(4 step)
IS	257	3.991	0.459	88.5	$TiO_2/V_2O_5/WO_3$(5 step)
MD	196	0.033	0.026	20.8	$TiO_2/V_2O_5/WO_3$(5 step)
DD	315	0.125	0.079	36.8	$TiO_2/V_2O_5/WO_3$(2 step)
	280	0.277	0.111	59.9	
	240	1.188	0.042	96.5	
Mean		1.450	0.166	88.6	

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References:

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