PCDD/PCDF REMOVAL OVER IMPREGNATED ACTIVATED CARBON USING ADSORPTION PROCESS IN MSW INCINERATOR.

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Introduction

In the past decade, the emissions of polychlorinated dibenzo-p-dioxins (PCDD) and polychlorinated dibenzofurans (PCDF) from municipal solid waste (MSW) incinerators have been a subject of increased environmental concern. The technologies of PCDD/PCDF removal have been developed through efforts of many researchers [1-4]. However, since PCDD/PCDF is very difficult to control, a perfect process has not yet been discovered. The possibility of removing harmful gas using carbon materials during adsorption process has been examined due to the unique characteristic of carbon materials themselves [5, 6]. As a result, it was induced that if alkali metal is impregnated in carbon material, the effect of controlling harmful chemicals is maximized [7-11]. In particular, potassium hydroxide (KOH) used as impregnant in this study has positioned itself as one of the promising chemical substances to increase removal efficiency by enhancing selective adsorptivity of PCDD/PCDF. The purpose of this study was, through performance tests by use of fixed bed adsorber, to examine adsorption characteristics according as PCDD/PCDF that was adsorbed on K-IAC.

Experimental

Sorbents

The adsorbent was prepared by impregnating a KOH (Junsei Chemical Co.) solution into granular activated carbon (GAC) made by coconut shell (Dongyang Carbon Co.). GAC was divided into a sieve fraction 8/16 mesh, treated with flowing N_2 for four hours at 140 °C. After that, it was dried at 383K and cooled in a desiccator. KOH was impregnated at an aqueous solution state in the GAC with a method of incipient wet impregnation, and was in use after it was dehydrated at 130 °C. Manufactured K-IAC was kept in a sealed container to prevent itself from reducing its life in the adsorption of moisture in the air and

impurity around. Through atomic absorption spectroscopy (AAS) analysis, potassium loading of K-IAC was confirmed to be 9.96 wt. %.

Methods

Adsorber was installed to MSW incinerator in Daejon, Korea. The capacity of MSW incinerator had 200 ton per day. The specification of adsorber is as follows: its diameter is 1.8 m, the flow rate is 734.6 m^3/h, linear velocity is 6.5 cm/sec. The fore end of adsorber included an electrostatic precipitator (ESP) for dust removal, cooler for appropriate temperature control and bagfilter. Fixed bed adsorption pilot plant system that is used in this experiment is shown in Figure 1. Material of 3-step horizontal type fixed bed adsorber was 316 stainless steel, and its inside diameter was 1.8 m (Figure 2). Because

carbon beds can capture entrained particulate, removal of the particulate before the bed or from the bed is an important design consideration. The carbon filter operating temperature is kept above 120 °C to minimize condensation corrosion in the bed and typically operates at about 150 °C. Flue gas from MSW incinerator was used as tested feed gas. Measurement and analysis of PCDD/PCDF were indicated 10^{-2}ng-TEQ/Nm^3 based on standard oxygen concentration. Evaluation of our method was performed on GC/MS. For the analyses were performed on a double focusing type mass spectrometer and Shimazu 14 GC with SP2331 60 m*0.32 mm ID *0.2 m film thickness.

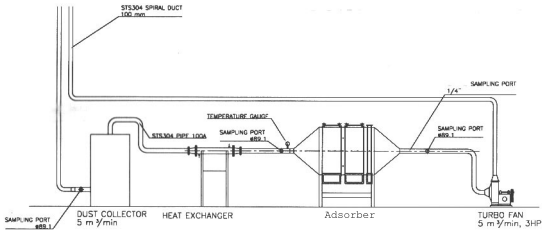

Figure 1. Adsorption process in MSW incinerator

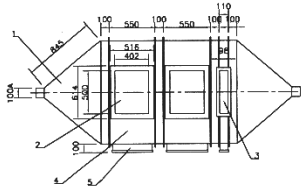

Figure 2. Horizontal type adsorber

Results and Discussion

Figure 1 shows tendency of total PCDD/PCDF removal efficiency before and after adsorption over KOH impregnated activated carbon. The concentration of total PCDD/PCDF in the feed gas introduced to adsorber was about 0.28 ng/Nm^3. After adsorption, the concentration of PCDD/PCDF was about 0.014 ng/Nm^3. The PCDD/PCDF removal efficiency using impregnated activated carbon in adsorption process was therefore 95.1 %.

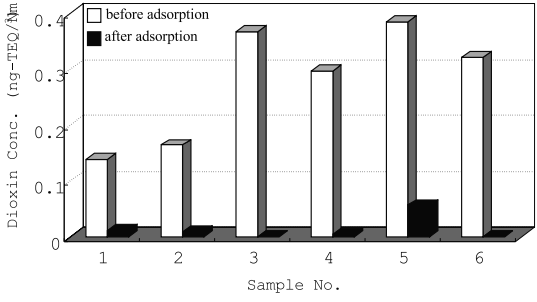

Figure 3. Exhausted concentration and removal efficiency of PCDD/PCDF.

Figure 2 and Figure 3 shows a comparative analysis of breakthrough curves as to particulated and gaseous PCDD/PCDF before and after adsorption. The particulate PCDD/PCDF was well removed more than gaseous PCDD/PCDF. The removal efficiencies for the particulate PCDD/PCDF ranged from 97.5 % to 100 %. The removal efficiency of gaseous PCDD/PCDF through adsorber ranged from 43.8 % and 100 %. The results of the experiment showed high adsorptivity of K-IAC in adsorbing

dioxins on activated carbon. The basic feature given to the surface of activated carbon by KOH impregnation was confirmed to be acting as the main factor in enhancing dioxins adsorptivity.

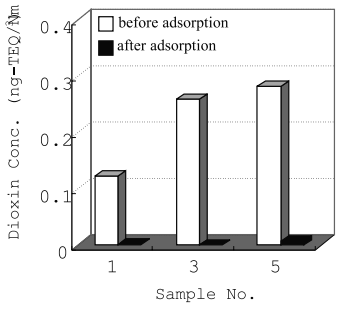

Figure 4. Exhausted concentration and removal efficiency of particulate PCDD/PCDF.

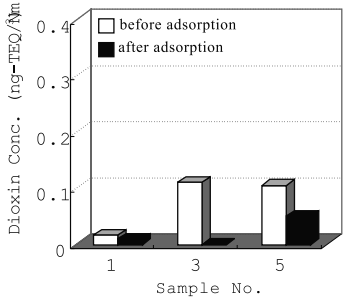

Figure 5. Exhausted concentration and removal efficiency of gaseous PCDD/PCDF.

The PCDF of 10 species and PCDD of 7 species were analyzed. Table 1 shows each species of PCDD/PCDF analyzed before and after adsorption. The removal efficiency for PCDD/PCDF species ranged from 86.7 % to 100 % (Figure 6).

Table 1. Analysis of adsorption test for isomers of particulate dioxins.

		Sample No.	Front side	Back side
Furan	2,3,7,8-T_4CDF	F1	0.044	0
	1,2,3,7,8-P_5CDF	F2	0.01	0
	2,3,4,7,8-P_5CDF	F3	0.122	0.006
	1,2,3,4,7,8-H_6CDF	F4	0.011	0.001
	1,2,3,6,7,8-H_6CDF	F5	0.024	0.002
	2,3,4,6,7,8-H_6CDF	F6	0.02	0.002
	1,2,3,4,6,7,8-H_6CDF	F7	0.003	0
	1,2,3,4,6,8,9-H_7CDF	F8	0.005	0.001
	1,2,3,4,7,8,9-H_7CDF	F9	0.001	0
	1,2,3,4,6,7,8,9-O_8CDF	F10	0.001	0
Dioxin	2,3,7,8-T_4CDD	D1	0.024	0.001
	1,2,3,7,8-P_5CDD	D2	0.021	0
	1,2,3,4,7,8-H_6CDD	D3	0.003	0
	1,2,3,6,7,8-H_6CDD	D4	0.007	0
	1,2,3,7,8,9-H_6CDD	D5	0.004	0
	1,2,3,4,6,7,8-H_7CD	D6	0.003	0
	1,2,3,4,6,7,8,9-O_8CDD	D7	0	0
	PCDFs	PCDFs	0.219	0.012
	PCDDs	PCDDs	0.074	0.002

The experimental results showed that the activated carbon manufactured from KOH impregnation could be appropriately used as adsorbents for removing dioxins. The number of basic surface site that has good selectivity with dioxins is important because the amount of PCDD/PCDF being chemically adsorbed has dominant effect due to the chemical characteristics of surface basic groups. In addition, we disclosed results that the value of pore volume or surface area does not have significant relation with the actual adsorption capacity of adsorbent. Therefore, it can be suggested that the degree of adsorptivity can largely be affected depending on basic hydroxide ion and catalysis of potassium that induce selective adsorption for dioxins in KOH, which is an impregnant.

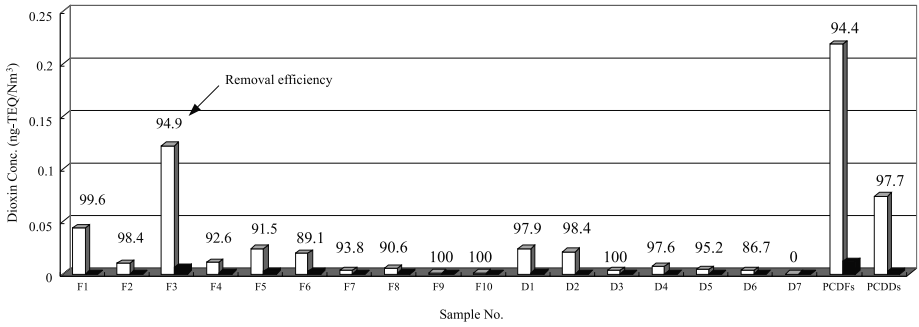

Figure 6. Removal efficiency of isomers of particulate dioxins over KOH impregnated activated carbon.

Acknowledgment

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