Effects of Dust Composition on Removal Characteristics for Dioxins.

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Introduction

Combustion controls of wastes and emission controls of dioxin(DXN) are the main ways for decreasing DXN discharge at municipal solid wastes incineration facilities. In Japan, effective technologies for decreasing DXN discharge have to be established as soon as possible, and many activity have been engaged in developing that technologies. Bag filter method (BF) is one of the methods most widely applied for the emission controls. A BF is believed to be effective in removing DXN due to its high collection efficiency for sub-micron dust that may contains DXN as well. Furthermore, a BF removes DXN by adsorbing gas phase DXN in flue gases on surfaces of collected dust [1]. However, no detailed investigations are reported on characteristics of BFs with respect to various flue gases. For example BF can not applied effectively to remove DXN from flue gases for melting system[2]. The report concludes that DXN in the flue gases would pass through BF, and that BF would be incapable of removing DXN in flue gases for melting system. The report seems to suggest that DXN in flues gases for melting system could not be adsorbed on the relevant dust. The present authors estimate that characteristics of dust generated at incineration facilities might be different from dust of melting systems with respect to DXN adsorption.

Thus, the present investigation is aimed to clarify effects of dust composition on removal characteristics for gas phase DXN.

Experiments

An experimental apparatus used in the present investigation is shown schematically in Fig. 1. The apparatus is installed at an operating waste incineration facility. A part of a flue gas of the plant is by-passed at an exit of a plant BF system to the apparatus as shown at the top left of the figure. A part of the by-passed flue gas is passed to four test cylinders through inlet valves of the test cylinders. Oxygen contents and moisture contents of the flue gas are measured with respective test gas cylinders attached to a gas introduction pipe. A remainder of the by-passed flue gas is

cooled and the gas flow rate is measured before being returned to the plant BF system. Three out of four test cylinders shown in the figure are utilized for testing various ash beds, and the remainder as a reference cylinder without an ash bed for analyzing an inlet concentration of DXN for the test cylinders. A flue gas sample in each of three test cylinders is collected after air in the cylinder is completely substituted with the flue gas flowing into the cylinder. Each of the three cylinders is provided with a dust bed of different composition for investigating effects of dust composition on removing characteristics of the bed for DXN.

Table.1 Test Conditions

Dust Bed	Filtering Rate (m/min)	Gas Temp (K)
Dust A	1.0	423
	1.0	523
Dust B	1.0	423
	1.0	523
Dust C	1.0	423
	1.0	523

Table.2 Dust Composition

	DustA	DustB	DustC
C (%)	4.0	<0.1	<0.1
Si (%)	5.8	9.2	0.1
Al (%)	4.5	6.2	0.04
Ca (%)	17.3	16.7	0.2
Na (%)	6.7	5.9	12.1
K (%)	7.5	6.3	7.7
Cl (%)	16.8	13.0	47.2
S (%)	2.2	2.2	9.6
others (%)	35.2	39.1	23.1

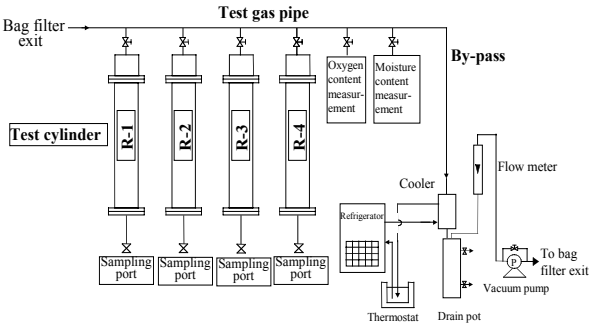

Fig. 1 Test Apparatus

Table 1 shows the test conditions, namely, two levels of test temperatures with a fixed flow rate of the flue gas in the test cylinders. The following dust beds of A, B and C are selected for the experiments, and the dust composition is shown in Table 2.

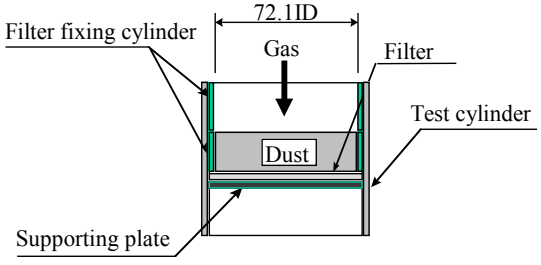

Fig. 2 Details of Test Cylinder

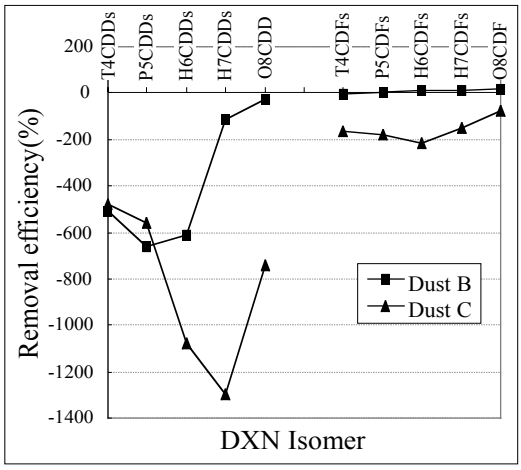

Fig. 5 Removal Efficiency of Dust Beds B and C for DXN Isomers at 523K

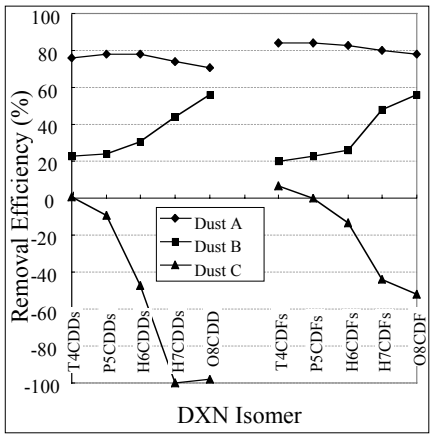

Fig. 3 Removal Efficiency of Dust Beds A,B and C for DXN Isomers at 423K

Dust A: This is a bed of typical fly ash that is collected from an operating stoker type municipal waste incineration plant. The bed contains oxides of Si, Al and Ca of 28% in the total elemental analysis and fixed carbon of 4.0%.

Stoker type incinerators are relatively popular in Japan.

Dust B: This dust is removed of the fixed carbon from the dust to less than 0.1 % according the following processes. The dust A is heated at 773K for two hours with air flowing. After the oxidation treatment, nitrogen gas is passed for one hour at 773K, and the carbon-free dust is cooled to room temperature while cool nitrogen gas is kept flowing through the dust.

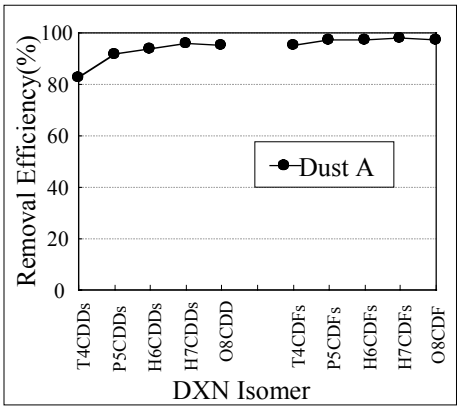

Fig. 4 Removal Efficiency of Dust Beds A for DXN isomers at 523K

Dust C: This is a bed of typical fly ash that is collected from flue gases of a melting system. The bed consists mainly of compounds of Na, K, S and Cl, the total as high as 78% of the total elemental analysis.

Results and Discussion

Fig. 3 shows removal efficiencies of dust beds A, B and C by adsorbing DXN isomers in the flue gas at 423K. The following results are obtained.

1. The removal efficiencies of dust A for all DXN isomers are higher than that of dust B. Therefore, the role of the fixed carbon in dust A for removing DXN is significant.
2. It is well known [3] that $CaCl_2$, a compound of $Ca(OH)_2$ and HCl, possesses no removing capacity for the DXN. Thus, the removal efficiencies of dust B for the DXN isomers ranging between 20% and 60% are believed due to a large removal efficiency of aluminosilicate present in dust B.
3. The data on dust C show large negative removal efficiencies for DXN isomers of higher chlorine contents. This behavior suggests that dust C increases contents of some DXN isomers.

Fig. 4 shows removal efficiencies of dust bed A for DXN isomers from the flue gas at 523K, and Fig. 5 shows those of dust beds of B and C. From these figures, the following results are obtained.

1. Dust A is found to be very effective in removing all DXN isomers from the flue gas at 523K, suggesting the role of the fixed carbon in dust bed A for removing DXN to be significant similar to the case at 423K.
2. Dust B does not remove DXN from the flue gas. Especially, PCDDs in bed B has increased. The change of the test temperature from 423 to 523K is believed to be the main reason for the different behaviors.
3. Dust C at 523K increases DXN in the gas sample than that at 423K. Again, the temperature effect is significant.

The role of fixed carbon in dust beds is confirmed to be significant in keeping removal efficiencies of dust for DXN to be high. Thus, similar adsorption tests are conducted with a test bed of dust C added with activated carbon of 1 wt.% at 423 and 523K. The activated carbon is commercial grade activated carbon of the specific surface area of 1,000m^2/g. The test results of removal efficiencies of the dust added with activated carbon are shown in Fig. 6 with respect to various DXN isomers. No difference is observed in the removal efficiencies with respect to the DXN isomers at 423K. However, only the removal efficiency for PCDDs is lower than those for other isomers at 523K. Thus, the role of fixed carbon is clearly seen to be significant in enhancing adsorption of DXN on dust beds based on the data in Figs. 5 and 6.

Conclusions

Removal efficiencies of dust beds for DXN with respect to dust composition are tested, and the following results are obtained.

1. The role of fixed carbon in removing DXN from flue gases is significant,
2. It was found that fly ash with a lesser extent than that of fixed carbon was shown the efficiencies for DXN removal. That might be for the activities of Al-Si oxide.
3. Beds consisting of fly ash of Na, K, Cl and S, totaling to 78 % of elemental analyses increase DXN contents in flue gas when the flue gas is passed through the beds even at 423K.

The above conclusions explain roles of BF for DXN as follows: DXN behave differently at BFs according to dust composition on the BFs.

References

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3. Kurata et.al., No.9 Conference of the Japan Society of Waste Management Experts,**1998,**p674-676

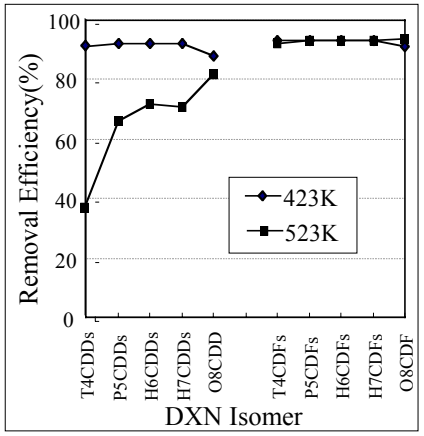

Fig. 6 Activated Carbon Addition Tests on Removal Efficiency for DXN Isomers at 423 and 523K(Dust C)