Dioxin Removal Characteristics by Bag Filter

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Introduction

As bag filters(BF) are effective in reducing emission of dioxins (DXNs) from waste incinerators, they have been introduced in many plants. BF is theoretically capable of removing DXNs (solid phase DXNs) contained in dust by filtration. It is understood that gas phase DXNs are attached to the dust and are then removed with the dust by filtration. In ash melting furnaces of municipal solid waste (MSW) incinerators, however, BF has been proven to be ineffective in controlling emission of DXNs as shown in Table 1 [1)].

Under the circumstances, the following four factors, which possibly give a large influence in gas phase DXNs removal by BF, have been investigated in this paper, in order to clarify removal characteristics of gas phase DXNs using flue gas from an MSW incinerator.

(1) Contact time of flue gas and dust
(2) Dust concentration in flue gas
(3) Amount of dust attached to filter cloth
(4) Specific surface area of dust

Table1 Removal efficiency by BF
(flue gas from melting furnace, 423K)

	Removal efficiency (%)
PCDDs	21.0
PCDFs	12.0
CBs	15.0
CPs	-84.0

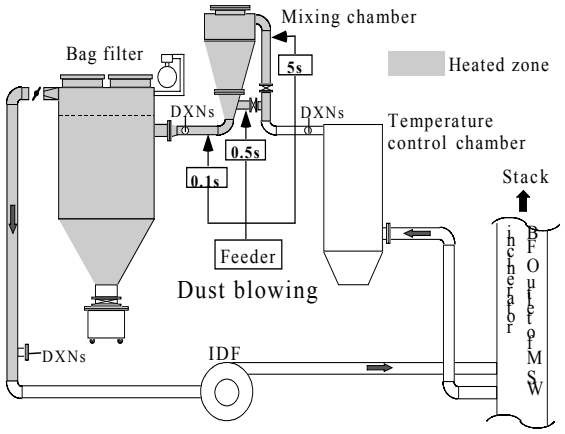

Fig.1 BF test plant flow

Experimental Equipment and Method

Fig. 1 shows the flowchart of the BF test plant. Table 2 shows the specification of equipment. For testing the flue gas containing gas phase DXNs only, we branched the flue gas which does not contain dust from the BF outlet (493K) of the existing MSW incinerator and led it to the test plant. The dust concentration in the flue gas was less than 2.3mg/m^{3}N (average 1mg/m^{3}N) during the entire test. The temperature condition was fixed at 423K and the equipment temperature was controlled at the range of 422-424K. The filtration rate of the BF test plant was fixed at 1.0m/min. The dust used for this experiment was the fly ash from MSW incinerator, which was blown into the test plant by heated air (423K). It is also confirmed that the DXNs concentration in the dust did not change even after the dust passed through the heated air line.

Table2 Specification of test equipment

Mixing chamber	contact time of gas and dust	0.5s or 5s
BF	filter cleaning	pulse jet by 0.25MPa compressed air
	area of filter cloth	10.3m^2
	dimensions of filter cloth	147φ?1300L ?18pieces

(1) Contact time and dust concentration

The contact time of the flue gas and the dust was varied by adjusting the dust blowing position (Runs 1-6). The contact time shown in Table 3 was the time between the blowing position and the BF inlet. The dust concentration in the flue gas was also varied by changing the amount of dust to be blown. For performing the test in the condition in which almost no dust exists, we cleaned the filters by pulse jet for a short interval (90s interval/filter cloth). The differential pressure between dust layers ranged from 40 to 50Pa during the test.

Table3 ? Test conditions

Run No.	dust concentration	contact time	differential pressure
	(g/m^{3}N)	(s)	(Pa)
1	1	0.1	40
2	1	0.5	50
3	1	5	50
4	10	0.1	50
5	10	0.5	50
6	10	5	50
7	0	0	0
8	0	0	5
9	0	0	10
10	0	0	100
11	0	0	200
12	0	0	400
13	0	0	700

(2) Amount of dust attached to filter cloth

The amount of dust on the filter cloth was changed by setting the differential pressure as indicated in Table 3 (Runs 7-13). The differential pressure is the value for the dust layer excluding the differential pressure of the filter cloth. The pressure 0 Pa is the value for filter cloth only.

The dust was injected before the measurement to form the dust layer until it achieves the differential pressure conditions as listed in Table 3. After the dust layer was formed, dust injection was stopped and then the measurement was started.

Results and Discussion

1) Contact time and dust concentration

As shown in Fig.2, the DXNs removal eff concentrations and the contact time of the flu measured at the outlet of BF was lower than 0.(at the inlet of BF ranging from 0.43-0.72ng-TE and the dust concentration do not have significa

*)Removal efficiency =([Mixing chamber inlet]-[BF outlet

2) Amount of dust attached to filter cloth

Fig. 3 and Table 4 show the results of Runs7-13. In Fig.4 the removal efficiency*) for each homologue is illustrated for Runs 7-9 as examples. For the condition of a filter cloth only (0kg/m^2), the DXNs removal efficiency*) is low and the removal efficiencies of the homologues with lower chlorine numbers tend to be lower. However, for the condition where even a small amount of dust is attached (0.03kg/m^2), both DXNs and homologues removal efficiency remarkably increase. When the dust attachment amount is 0.14kg/m^2 or over, both DXNs and homologues removal efficiencies exceed 90%. According to the results, it is clear that the existence of the dust on a filter cloth plays an important role to gas phase DXNs removal by BF.

*)removal efficiency =([BF inlet]-[BF outlet])÷[BF inlet]×100

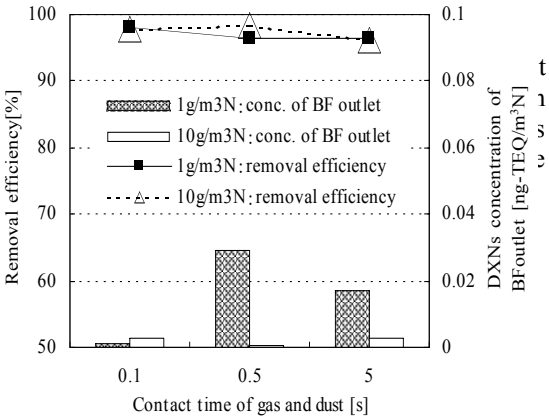

Fig.2 Effect of contact time and dust concentration

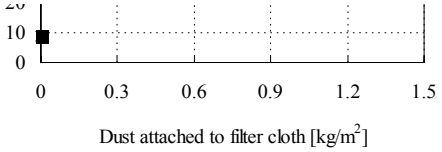

Fig.3 Effect of attached dust on DXNs removal efficiency

Table4 Test results of Runs 7-13

Run No.		7	8	9	10	11	12	13
dust attached to filter cloth	kg/m^2	0	0.03	0.14	0.39	0.71	0.83	1.45
DXNs concentration at BF outlet	ng-TEQ/m^{3}N	0.62	0.031	0.010	0.0044	0.0033	0.0034	0.019
removal efficiency of DXNs	%	8.8	84	94	94	96	94	91

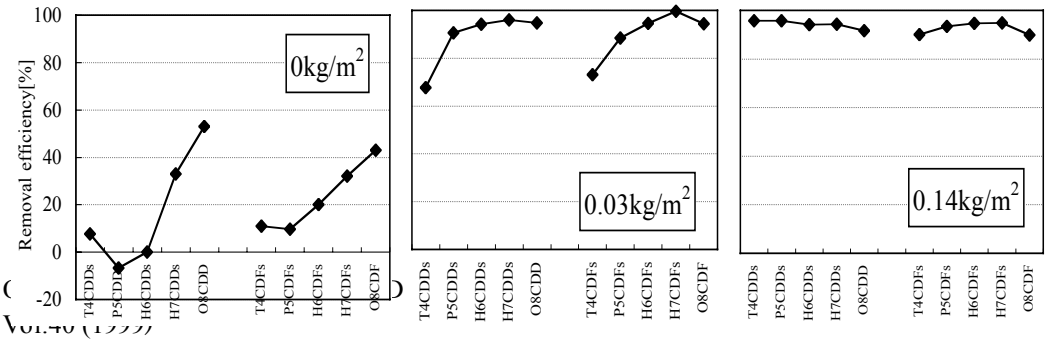

Fig.4 Removal efficiency for each homologue (Runs 7-9)

3) Specific surface area of dust

The components in dust considered possibly effective for absorption of DXNs are fixed carbon, the main component of activated carbon, and the oxides used as absorbents. In this paper the focus is placed on fixed carbon in the dust. The fixed carbon is discharged in the shape of flakes during incomplete combustion.

Table 5 shows specific surface area of dust samples used in Runs 10-13. The specific surface area of dust after removing fixed carbon is about 0.8-0.9m^2/g. Calculating from this value, the specific surface area of the fixed carbon itself is about 300-900m^2/g. This value is almost equivalent to that of activated carbon (600-1000m^2/g) which is currently in commercial use. Therefore, it may be concluded that high DXNs removal as shown in Table 4 is attributed to the fixed carbon in the dust.

Table5 Specific surface area of dust sample

Run No.	Content of fixed carbon (a)	specific surface area(m^2/g)		
	%	original sample (b)	sample after removing fixed carbon*1) (c)	fixed carbon (calculated value)*2)(d)
10	3.5	10.9	0.9	287
11	3.2	12.4	0.9	363
12	3.5	27.9	0.8	774
13	3.2	28.4	0.9	861

*1) treated by 773K air for 2 hrs

*2) d=100÷a?b-(100-a)÷a?c

Conclusion

According to the test results by using flue gas (423K) from an MSW incinerator, the following conclusions are obtained with respect to the removal characteristics of gas phase DXNs.

(1) The contact time of flue gas and dust up to BF inlet as well as the dust concentration in flue gas does not have significant effect on DXNs removal.

(2) Only a small amount of dust attached to the filter cloth is significant for high removal of all homologues (Cl numbers 4-8).

(3) The fixed carbon in the dust has equivalent specific surface area to activated carbon, which may attributes to high adsorption efficiencies.

Reference

1) Kokado, M.; The 9th Annual Conference of the Japan Society of Waste Management Experts, 1998, pp. 665-667