

DECOMPOSITION APPARATUS OF DIOXIN IN FLY ASH FROM MUNICIPAL REFUSE INCINERATOR

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Almost of dioxin in flue gas emitted from municipal solid waste incinerators is removed at de-dust treatment with the precipitator, thereby emission level of dioxin is able to be reduced below 0.1 ng-TlEQ/Nm^3 with the low-temperature bag filter that is very effective for the collection of dust than that of the electrostatic precipitator.¹

For this reason, in the fly ash the dioxin content is high level, so is need to reduction of dioxin. We report the results of tests which is conducted with laboratory and bench to accomplish the elimination of dioxin in the fly ash.

TESTS

LABORATORY TESTS Fig.1 shows a schematic flow diagram. The ash sample was bag filter ash from a stoker type incinerator and was heated in the reactor with the electric furnace.

Table 1 shows the test conditions.

BENCH SCALE TESTS Fig.2 shows a schematic flow diagram. The device consists of a double shaft of oval gear for ash feeding, mixing paddles and electric ribbon heaters on charge and hopper. Ash was pre-heated in the hopper at 150°C , then heated up in the charge. Thermocouples were inserted into ash layer to measure actual temperature. Treatment capacity (MAX. 10kg/hr) of ash was adjusted by shaft revolutions. Nitrogen gas was passed to control oxygen concentration in gaseous phase. Treated ash is sampled into a sampling vessel which added dry-ice to it and is cooled rapidly.

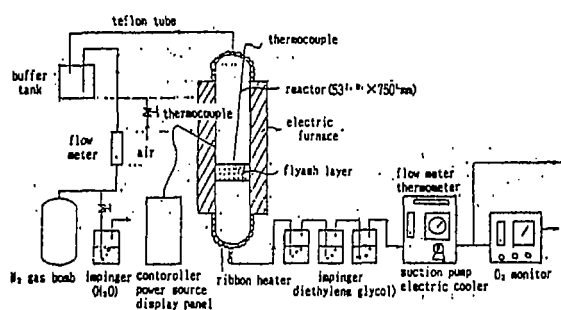


Fig. 1 Thermal Treatment Apparatus

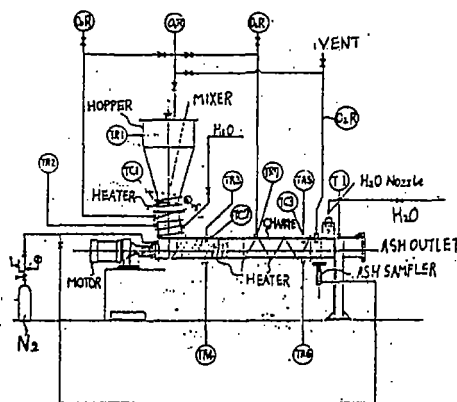


Fig. 2 Bench Scale Device

RESULTS AND DISCUSSION

LABORATORY TESTS Table 1 and Fig. 3~Fig. 5 shows the results of analysis on dioxin. Fig. 3 indicate that the removal efficiency of dioxin increase in nitrogen stream as the ash temperature increase and reduce rapidly at 200°C or so and decompose to completely at 400 °C.

As in nitrogen stream the retention time increase, dioxin concentration has increased and its removal efficiency can reach over 99% at 300 °C or more. As 0.3% at the maximum of dioxin is vapolized from ash into gas phase, it is demonstrated that the elimination of dioxin is not dependent to vapolizing into gas phase but dependent to decomposition in ash layer.

The formation of dioxin is influenced with O₂ concentration in gas phase and it increase by a factor of 1.5 in comparison with non-treated ash under the conditions of 300 °C, 2HR, 10% O₂.

Table 1 Thermal Behavior of Dioxin in Fly Ash (Labo. Test)

Sample		Non Treated	RUN 1	RUN 2	RUN 3	RUN 4	RUN 5
Test	Atmosphere	—	N ₂	N ₂	N ₂	O ₂ 10%	O ₂ 10%
	Temp. (°C)	—	200	300	400	200	300
Corrosion	Time (hr)	—	2	4	2	2	2
	Gas Stream(N ₂ /hr)	—	40	40	40	40	40
Fly Ash	PCDDs (ng/g)	49	30	0.8	0.1	57	57
	PCDFs (ng/g)	95	7	1.0	< 0.1	77	158
	Sum (ng/g)	144	37	1.8	0.1	134	215
Vapourized	PCDDs (ng/g)	—	0.3	0.4	ND	ND	ND
	PCDFs (ng/g)	—	ND	ND	ND	ND	ND
	Sum (ng/g)	—	0.3	0.4	ND	ND	ND

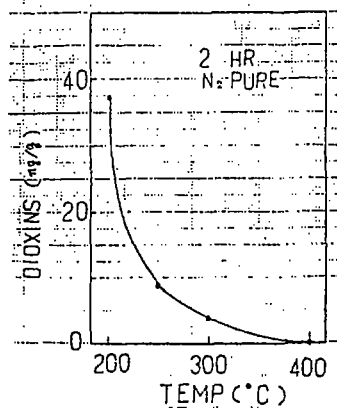


Fig. 3 Effect of Annealing Temperature for Dioxin Decomposition on Fly Ash

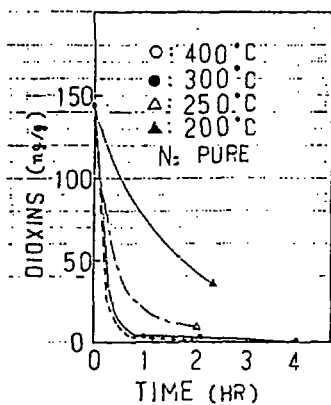


Fig. 4 Effect of Annealing Time for Dioxin Decomposition on Fly Ash

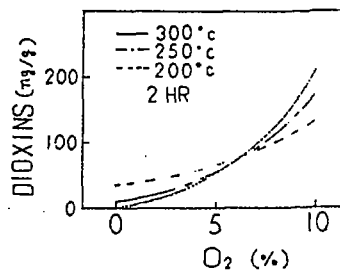


Fig. 5 Effect of Oxygen Concentration for Dioxin Decomposition on Fly Ash

BENCH SCALE TESTS Table 2 and Fig. 6 ~Fig. 7 shows the results of analysis on dioxin and Hg. As the removal efficiency of dioxin is influenced with ash temperature, its efficiency increase from higher ash temperature to higher. Its efficiency is nearly equal to between 1HR and 2HR at 400°C, thereby the retention time of ash is sufficient for 1HR.

As O₂ concentration raise, the formation of dioxin improve, so the removal efficiency of dioxin tend to fall, however it is possible to reduce over 95% and over 99% under the condition of 400°C, 1HR, 10% O₂ and 400 °C, 1HR, below 5% O₂ respectively.

It is demonstrated that our device is very effective for removing dioxin and Hg. For this reason, the following point may be considered. The double shaft of oval gear type is excellent in comparison with a single shaft screw type for mixing, feeding and heating of ash. As the vaporizing efficiency of Hg and residual concentration of Hg in ash reach respectively 77%, 99% and 1.6 μg/g, 0.08 μg/g at 350°C×0.5HR or 400°C×2HR, it is observed that Hg in ash is decomposed together with dioxin decomposition.

Table 2 Reduction of Dioxin and Hg by Continuous Heating Treatment

Sample	Non Treated	RUN 6	RUN 7	RUN 8	RUN 9	RUN 10
Ash Temp. (°C)	—	350	350	400	400	440
Retention Time (hr)	—	0.5	2.0	2.0	1.0	0.5
O ₂ (%)	—	<1 %	<1 %	<1 %	10	<1 %
PCDD _a + PCDF _s (ng/g)	630	29	22	0.22	20	15
Dioxin Decomposition ratio(%)	—	95	97	>99.9	97	96
Hg in Fly Ash (μg/g)	6.9	1.6	1.5	0.08	—	0.42
Hg Decomposition ratio(%)	—	77	78	99	—	94

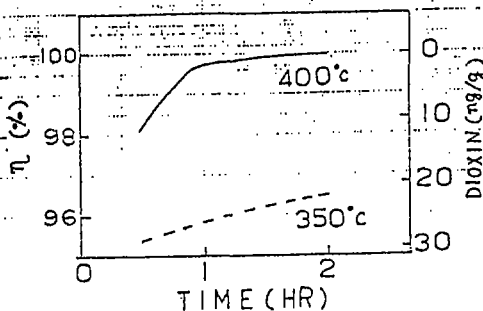


Fig. 6 Effect of Annealing Time for Dioxin Decomposition on Fly Ash at O₂ 1% Less (Bench Scale Tests)

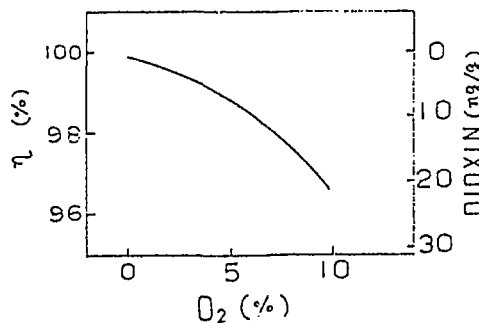


Fig. 7 Effect of O₂ Concentration for Dioxin Decomposition on Fly Ash at 400°C, 1 HR (Bench Scale Tests)

CONCLUSION

- (1) It is recognized that is required to maintain the temperature of 400 °C, the retention time of 1 HR and O₂ concentration of below 5% in order to obtain the level of removal efficiency of dioxin upper 99% and the residual content in ash below 0.01ng-TEQ/g.
- (2) Hg in ash is vaporized nearly 99% together with when the treatment of decomposition of dioxin is performed, thereby we expected that the process of removal and recovery of Hg in ash is possible to achieve at high efficiency by the joint of Hg recovery technique which we possess.
- (3) The rate of decomposition for PCDDs in ash is faster than that of PCDFs and high chlorinated compounds is faster than low chlorinated compounds.
- (4) The elimination of dioxin is dependent on decomposition in ash layer.
- (5) Most of Hg in ash is vaporized at the temperature that dioxin is decomposed.
- (6) As O₂ concentration in gas phase falls, decomposition of dioxin is proceeded.

1. Shida S, Doi T et al. DXX KYOTO' 91 1991; 177~184