BEHAVIOR OF DIOXINS AND POLYCYCLIC AROMATIC HYDROCARBONS IN VERIFICATION TEST FACILITY (GASIFICATION MELTING FURNACE)

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Introduction

Due to insufficiency of final waste disposal capacity in Japan, the current waste disposal management policy is shifting toward recycling and reduction in the amount of waste produced. Accordingly, incineration plants have begun to use gasification melting furnaces, ash melting furnaces, RDF power generators, etc. as well as conventional equipment.

There is a possibility that heat treatment of waste may release toxic substances contained in waste without decomposing or may allow other chemical substances to be generated incidentally. It is necessary to clarify the effects on the environment of non-restricted substances such as polycyclic aromatic hydrocarbons (PAHs) as well as dioxins already under restriction, but there are insufficient information and reports on the behavior of such toxic substances.

Therefore, the authors conducted an investigation into the behavior of these substances using a gasification melting furnace in the verification test, which is considered to be a next-generation waste disposal method. This report covers the behavior and concentration level of dioxins and polycyclic aromatic hydrocarbons in the processes of the said facility.

Method of investigation

(1) Facility

A circulating fluidized bed type gasification melting furnace was used in this investigation. An outline of the facility is shown in Table 1 and the process flow in Fig. 1.

(2) Sampling points, measured items and operating conditions

Samples were collected at the sampling points denoted by G1 to G5 in Fig. 1 during normal operation of the plant. Table 2 shows the plant operating conditions.

Table 1 Outline of the facility of gasification melting furnace

Capacity	1 line x 20 t/24 h
Gasification system	Circulating fluidized bed
Melting system	Rotary kiln
Combustion gas cooling system	Waste heat boiler and water spray
Flue gas treatment system	Dry slaked lime atomization + Bag filter + SCR

Table 2 Plant operating conditions

Condition	Unit	Average data
Waste treatment rate	kg/h	850
Free board gas temperature of gasification furnace	°C	800
Melting furnace outlet gas temperature	°C	1,350
Secondary combustion chamber outlet gas temperature	°C	950

Results of measurement

Table 3 shows an analysis of the flue gas collected at the G1 to G5 sampling points. Fig. 2 shows the changes in concentration of dioxins with the advance of flue gas flow.

Discussion

Fig. 2 indicates that the concentration of dioxins at the exit of the air preheater of the melting furnace increased to 1.4 ng-TEQ/m^3_N from 0.12 ng-TEQ/m^3_N measured at the inlet, suggesting secondary formation of dioxins inside the air preheater. Dioxins were then removed with a bag filter and decomposed in a catalytic tower to an extremely low level of concentration. Fig. 3 indicates that the total PAHs concentration shows a similar tendency to that of dioxins. This is because the concentration of total PAHs is governed by the behavior of naphthalene. Fig. 4 shows details of the changes in PAH concentration by individual substances. From these graphs, we see a variety of changes in concentration among these substances until they have passed through the air preheater: some are increased, some decreased and some remain unchanged. We also see that these substances are then caught and removed with a bag filter to a lower concentration. The graphs indicate that the PAHs concentration is not changed at all, or slightly decomposed and increased by catalysis. However, these changes in the PAHs concentration were so small that they could be the result of measuring error and fluctuation with time or, more probably, from the temperature changes inside the system due to absorption and evaporation. In any case, no obvious decomposition was observed.

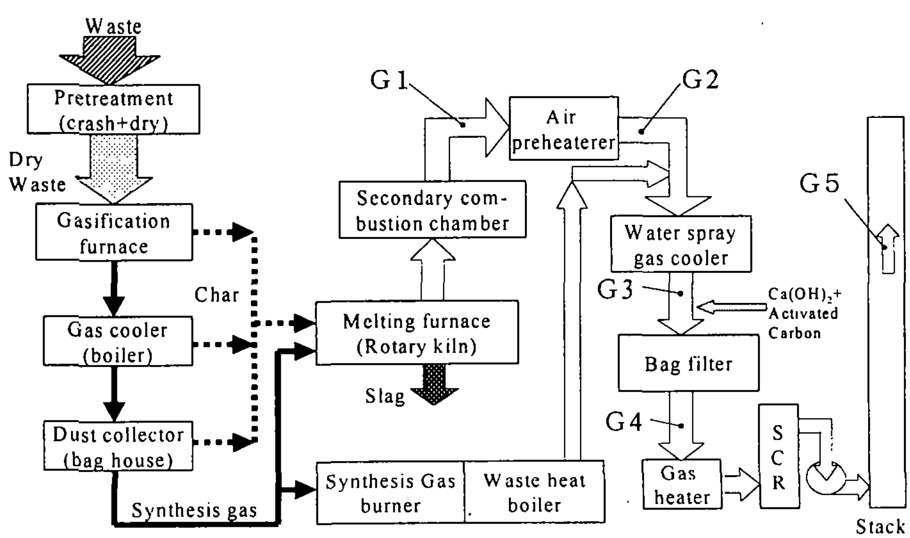


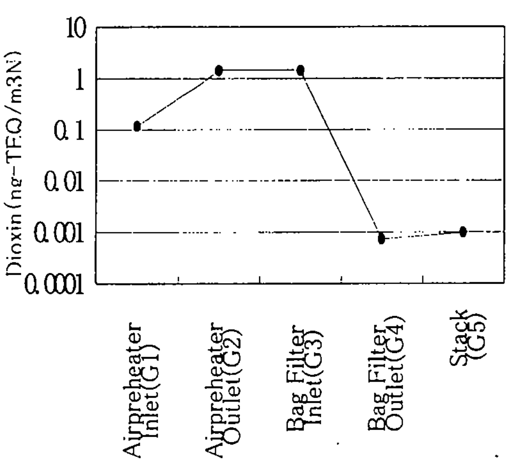
Fig.1 Process flow of Gasification and Melting system

Table3 Analysis of flue gas

Measured data were converted into the value in O_2 12%.

Item	Unit	Air preheater		Bag filter		Stack (G5)
		Inlet (G1)	Exit (G2)	Inlet (G3)	Exit (G4)	
Gas temperature	°C	681	325	150	140	239
Oxygen concentration	%	2.5	8.2	7.9	8.4	8.4
Carbon monoxide	ppm	7	9	4	5	9
Dioxins	ng-TEQ/m^3_N	0.12	1.4	1.3	0.00084	0.00098
Total PAHs	ng/m^3_N	5,490	7,567	5,095	3,602	2,548
Naphthalene	ng/m^3_N	4,900	6,900	4,400	3,400	2,400
Acenaphthylene	ng/m^3_N	18	44	36	7.1	6.9
Acenaphthene	ng/m^3_N	8.3	22	16	8.6	4.9
9H-Fluorene	ng/m^3_N	58	84	82	79	36
Phenanthrene	ng/m^3_N	92	170	330	43	35
Anthrathene	ng/m^3_N	120	98	89	29	32
Fluoranthene	ng/m^3_N	29	65	54	9.3	9.3
Pyrene	ng/m^3_N	44	70	47	15	12
Benzo [a] anthrathene	ng/m^3_N	25	15	5.5	<3.6	<3.6
Crysene[1)]	ng/m^3_N	43	32	12	3.9	4.8
Benzo [b] fluoranthene	ng/m^3_N	68	34	14	6.6	6.9
Benzo [k] fluoranthene[2)]	ng/m^3_N	<2.4	8.4	4.2	<3.6	<3.6
Benzo [a] pyrene	ng/m^3_N	31	13	5.2	<3.6	<3.6
Indeno [1,2,3-cd] pyrene	ng/m^3_N	27	6.1	<3.4	<3.6	<3.6
Benzo [g,h,i] perylene	ng/m^3_N	22	5.9	<3.4	<3.6	<3.6
Dibenzo [a,h] anthrathene[3)]	ng/m^3_N	4.5	<3.5	3.4	<3.6	<3.6

1) Including triphenylene, 2) Including benzo [j] fluoranthene, 3) Including dibenzo [a,c] anthrathene



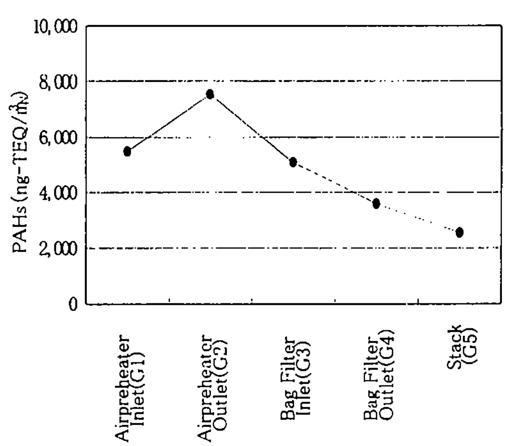
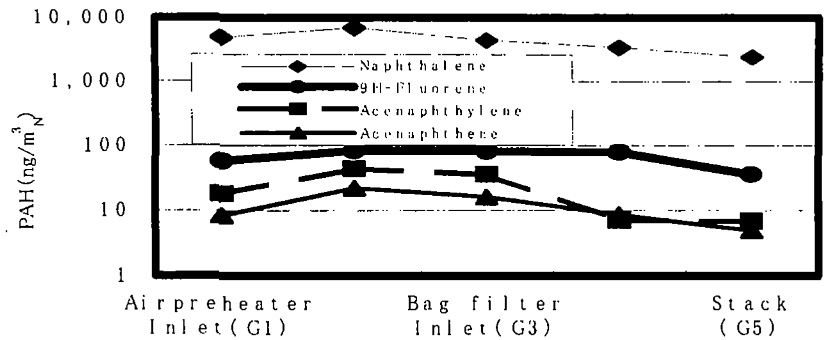
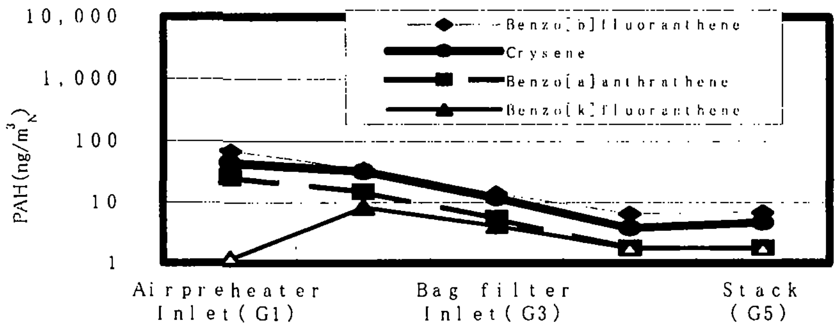
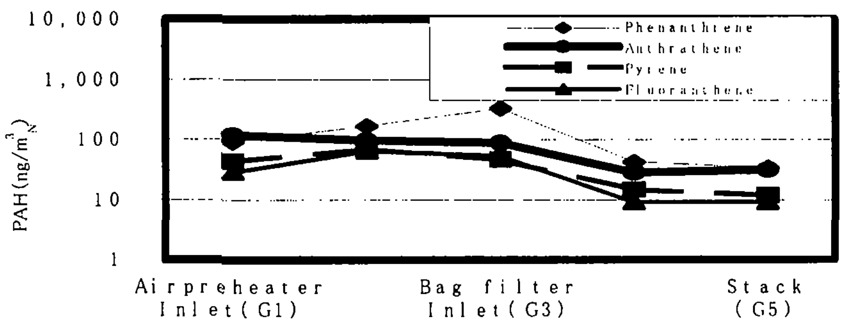
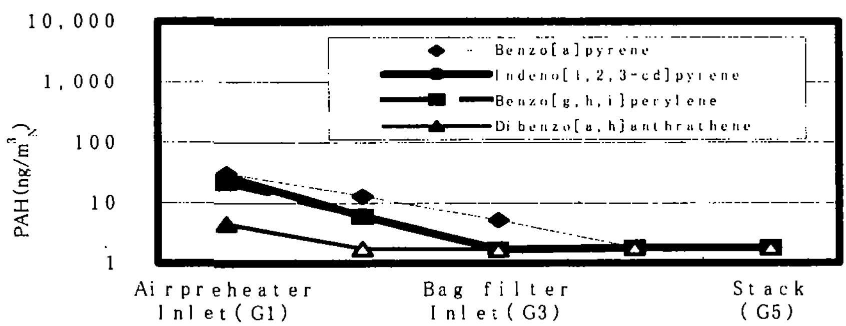


Fig. 2 Changes in concentration of dioxins **Fig. 3 Changes in concentration of total PAHs**









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