SIMULTANEOUS CONTROL OF DIOXINs AND NOx IN MUNICIPAL WASTE INCINERATOR

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INTRODUCTION

In Municipal Waste Incinerators (MWI's) the NOx emission problem had not been carefully studied from the viewpoint of simultaneous DIOXINs control until recently.

Because NOx formation is predominantly affected by combustion conditions as well as DIOXINs[1][2], when we discuss controlling the formation of DIOXINs and their precursors formation NOx control is also increasing in its importance in environmental terms.

By using NKK two-way gas flow MWI plants we carried out tests and research focusing primarily on the simultaneous control of DIOXINs and NOx and also on the control factors of DIOXINs in flue gas treatment systems.

KEYWORDS

DIOXINs, 2378-TCDD equivalent, NOx, Simultaneous control, CO, THC, Dust collector, Flue gas temperature, Flyash, Two-way gas flow MWI

EXPERIMENT CONDITIONS

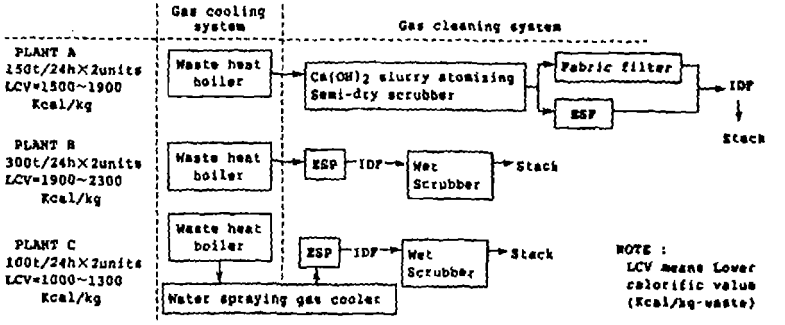

Fig.1 Relevant data and schematic flow diagrams

The experiments were performed in three NKK two-way gas flow MWI plants. These plants were chosen taking into account the difference in performance characteristics of flue gas cooling and cleaning system which influence the formation of DIOXINs. Relevant data and schematic flow diagram of these three plants are shown in Fig.1.

In PLANT A, a Fabric Filter(FF) with a capacity of 10,000Nm^3/h was installed in the by-pass gas flow line of the ESP in order to compare the characteristics of DIOXINs formation in ESP and FF.

ANALYSIS METHOD

Flue gas samples were drawn isokinetically using the serial five-impinger method, with the dust collecting apparatus set outside of the flue duct. Pretreatment of the gas sample consisted of extraction by toluene (after HCl treatment for dust components), addition of internal standards of ^{13}C-2,3,7,8-T_4CDD, ^{13}C-O_8CDD, ^{13}C-2,3,7,8-T_4CDF and ^{13}C-O_8CDF, condensation and then clean-up by columns. Mass-fragmentography by GC-MS was used for analyzing samples using DB-5 or SP-2331 as a separation column. Two mass numbers from M$^+$,M+2 and M+4 were simultaneously monitored, identified as PCDDs or PCDFs if the monitored intensity ratio was near that of the standards and quantified by the area of peaks. Standards include all 2,3,7,8-substituted isomers.

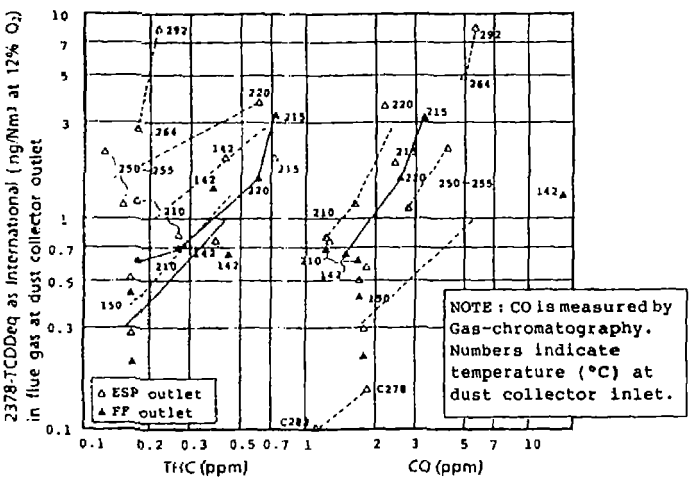

Fig.2 THC and CO VS 2378-TCDDeq as International in flue gas
(NOTE : CO is measured by Gas-chromatography)

RESULTS AND CONSIDERATION

1) Relationship between DIOXINs and combustion conditions

We investigated the relationship between DIOXINs concentration (2378-TCDD equivalent), carbon monoxide (CO) and total hydrocarbon (THC) regarded as the two major parameters of good combustion.

Fig.2 shows the test data marked with inlet flue gas temperature of the dust collector which has a definite direct relation to DIOXINs formation.

(1) There is a direct relation between DIOXINs and CO/THC.

(2) THC has a more definite relation to DIOXINs than does CO.

(3) Monitoring of DIOXINs can be made by means of continious CO analyzer.

In conclusion, it is a very important factor to enhance the secondary combustion of uncombusted gas and reduce CO/THC concentrations.

2) Relationship between DIOXINs and dust collecting system / flue gas temperature

In Fig.3 test data is presented marked with the THC concentration, the type of dust collector and flue gas cooling system which can be identified by plant.

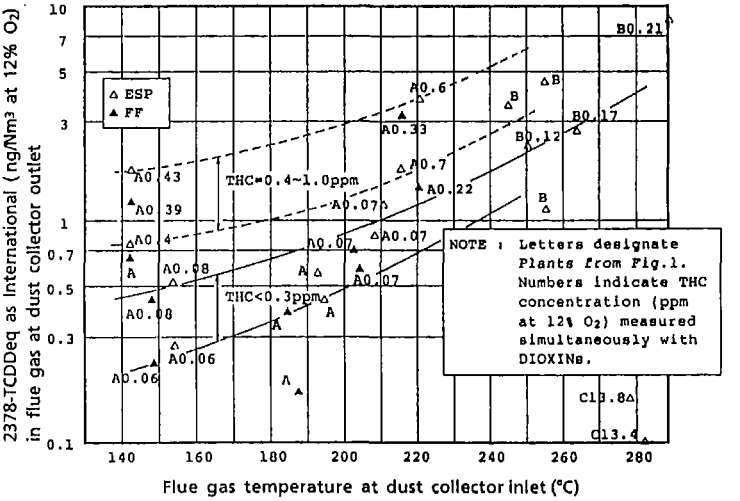

Fig. 3 Flue gas temperature at dust collector inlet VS. 2378-TCDDeq as International in flue gas at dust collector outlet

(1) There is a clear direct relation between DIOXINs and the inlet flue gas temperature of the dust collector, whether in ESP or FF.

(2) There is the tendency that when inlet flue gas temperature rises to more than 250°C the direct relationship mentioned above (1) becomes more definite.

(3) Compared with the DIOXINs at the outlet of the dust collector under the same combustion conditions, DIOXINs at the FF outlet are lower than the ESP by 30-40%.

(4) Compared with PLANT A and B equipped with a waste heat boiler as a gas cooling system, under the same gas temperature at the dust collector, DIOXINs at the dust collector outlet of PLANT C in which by using a water spraying system the flue gas temperature decreased rapidly from 600°C to 280°C are 90-98% lower than PLANTS A and B. These results are believed to be caused by the low CO concentrations (about 1ppm) at the furnace outlet and combusted municipal waste from which the plastic content is extracted at the time of collection.

3) Relationship between DIOXINs in flyash and operating conditions
We estimated test data according to the type of dust collector and gas cleaning system and the level of CO/THC concentrations.

(1) There is a direct relation between DIOXINs in flyash and CO/THC in the flue gas.

(2) There is a direct relation between flue gas temperature at the dust collector inlet and DIOXINs in flyash as well as in flue gas.

(3) When the CO/THC level in flue gas is low, no remarkable difference of DIOXINs level in flyash between ESP and FF can be recognized.
On the other hand, the higher the CO/THC level or flue gas temperature at dust collector inlet rises, the more DIOXINs are detected in flyash and this tendency can be recognized more definitely in FF flyash than in ESP flyash.
From these results, if we employ a Fabric Filter as a dust collector it is important to reduce the flue gas temperature at the FF inlet as low as possible.

4) Combustion characterestics in two-way gas flow MWI

Fig.4 shows the process data such as NOx, CO and O_2. This data was collected during experiment period in PLANTs A, B and C.

(1) Although O_2 ranges widely from 6 to 12 percent, CO level is kept low (less than 20ppm at 12%O_2).
This means a high degree of flue gas mixing and good secondary combustion in the secondary combustion zone.

(2) NOx concentrations become lower as O_2 concentrations are kept lower.
This means that low oxygen furnace operation, which results in two-stage combustion in the MWI, is effective in controlling NOx which mainly consist of fuel NOx.

(3) The temperature in the secondary combustion zone becomes higher as O_2 concentrations are kept lower.
These results show that for the purpose of NOx control, low oxygen (6-10%) furnace operation is needed on the condition that a low CO level is maintained (less than 20ppm at 12% O_2).

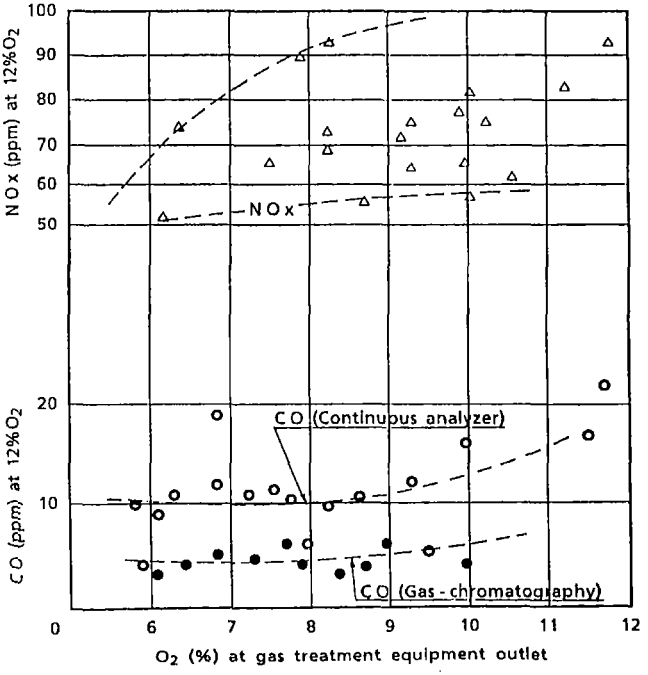

Fig.4 O_2 vs. CO and NOx at gas treatment equipment outlet

CONCLUSIONS

In MWI plants operating conditions to control DIOXINs and NOx emissions are summarized as follows :

DIOXINs CONTROL : LOW CO LEVEL,
LOW FLUE GAS TEMPERATURE AT INLET OF DUST COLLECTOR

NOx CONTROL : LOW O_2 OPERATION BY MEANS OF TWO-STAGE COMBUSTION

Consequently, for the purpose of simultaneous control of DIOXINs and NOx it is important to improve characteristics of combustion gas mixing and secondary combustion in the secondary combustion zone of the furnace and to maintain flue gas temperature at dust collector inlet at less than 250°C. Moreover these operating conditions benefit waste heat recovery in MWI plants.

REFERENCES

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