ANALYSIS OF CHLOROPHENOL MONITORED BY AN ON-LINE MONITORING SYSTEM FOR DIOXIN PRECURSOR IN FLUE GAS

Yoshinari Hori[1], Masuyoshi Yamada[2], Taku Saito[3], Nobuo Takeda[4], Takeshi Fujiwara[4]

[1] Power & Industrial Systems R&D Laboratory, Hitachi, Ltd. 832-2, Horiguchi, Hitachinaka, Ibaraki 312-0034, Japan

[2], Central Research Laboratory, Hitachi, Ltd., 1-280, Higashi-Koigakubo, Kokubunji, Tokyo, 185-8601, Japan

[3] Environmental Systems Cluster, Instruments, Hitachi, Ltd, 882 Ichige, Hitachinaka, Ibaraki 312-8504, Japan

[4] Department of Environmental Engineering, Graduate School of Engineering, Kyoto University, Yoshidahon-machi, Sakyo-ku, Kyoto, 606-8501, Japan

Introduction

It is important to analyze the generation process and behavior of dioxins in various operations of municipal waste incinerators in order to reduce their emission. However quantitative measurements of dioxins by GC/MS take more than one week due to their complicated sampling and extracting process. Therefore some on-line systems for monitoring surrogates of dioxins are being developed[1,2]. We chose chlorophenol as a surrogate for dioxins and developed an on-line system for monitoring it in flue gas[3].

The purpose of this study is to analyze the behavior of trichlorophenol (T_3CP) monitored with the on-line system in various operations of a stoker furnace.

Method

An On-line monitoring System: Figure 1 shows a schematic drawing of the chlorophenol on-line monitoring system. The incinerator flue gas is carried to the monitor through a filter to remove ash or dust. The filter and piping are heated at 200℃ to avoid trace gas adsorption. As an ionization method, the negative atmospheric-pressure chemical-ionization (APCI) method is used. Ions generated by APCI are sent to the ion-trap mass spectrometer (ITMS) and analyzed. To calibrate concentration of T_3CP in flue gas, T_3CP labeled with ^{13}C at a constant concentration is added to the flue gas to compensate for the varying ionization efficiency (Fig. 1).

Operations of a Stoker Furnace: We analyze the behavior of T_3CP in two stoker furnaces (furnace A and furnace B). We also analyze the behavior of carbon monoxide (CO) to compare their difference. The stoker furnaces have an electrostatic precipitator (EP) in the post-furnace region. The on-line system for T_3CP and CO is installed after the EP. In furnace A, T_3CP is monitored under normal operational conditions for about 1 month. In furnace B, T_3CP is monitored under the operational conditions which vary flue gas temperature in the post-furnace region.

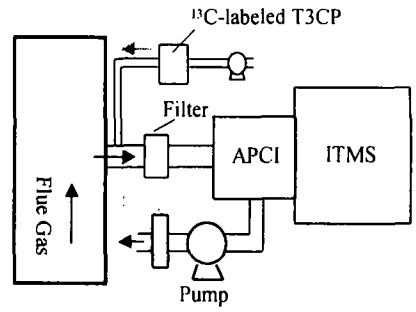


Fig. 1 Schematic drawing of monitoring system

Results and Discussion

Furnace A: Figure 2 shows typical trend data of T_3CP and CO on a weekend in furnace A. Figure 3 shows those data on a weekday. These figures tell us the behavior of CO is similar on a weekend and a weekday, but the behavior of T_3CP on the two is different. The concentration of T_3CP from 9:00 to 12:00 is higher than that in other periods. Figure 4 shows the average of T_3CP concentration in two periods in one month. The feature noted above is clarified by the figure.

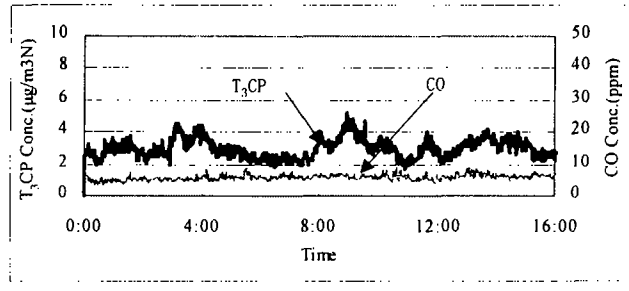


Fig.2 Trend data on a weekend

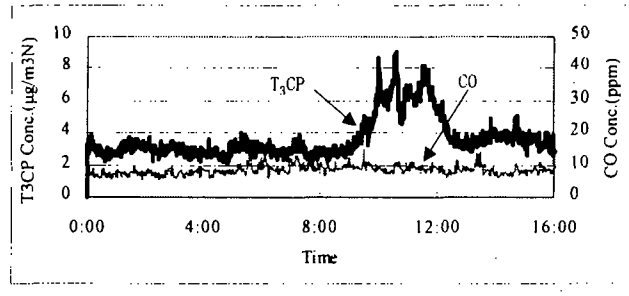


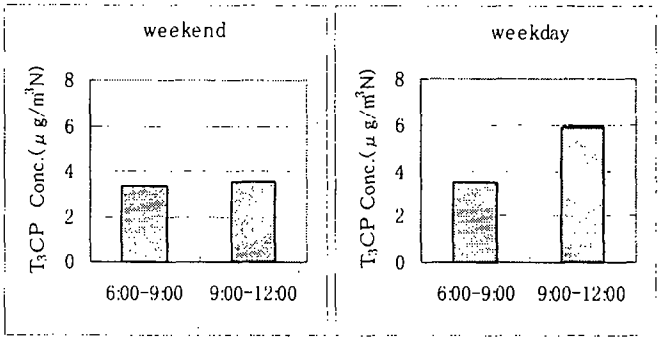
Fig.3 Trend data on a weekday

It is quite likely that the difference in T_3CP concentration in these periods is because of the difference of refuse burning in the period. That is to say, much refuge is collected in the morning on weekdays. So the refuge is put into the furnace as soon as it is collected without mixing in a refuse pit. It seems that this is the reason why the concentration of T_3CP from

9:00 to 12:00 is higher compared with other times.

Much experience has shown that mixing refuse well in a refuse pit is effective to reduce emission of dioxins. It is likely that we can recognize the effect by monitoring T_3CP.

Furnace B: Furnace B has no boiler system, so high temperature gas from the furnace is cooled by gas cooling equipment. The gas temperature at the exit of the gas cooling equipment is usually about 280℃. After that, gas flows through a reaction tower to reduce the hydrogen chloride concentration in the flue gas and then it flows into the EP. The gas temperature at the entrance of the EP is usually about 190℃. Figure 5 shows trend data for T_3CP and CO in furnace B under operational conditions which vary flue gas temperature in the post-furnace region. In this test, the set point of the flue gas temperature in the post-furnace region is increased in 10℃ intervals from 270℃ to 300℃. As shown in Figure 5, the average concentration of CO is about 15ppm and the burning condition of furnace seems to be stable. The behavior of T_3CP has the following two features.



(a)Weekend (b)Weekday

Fig.4 Average of T_3CP concentration (1 month)

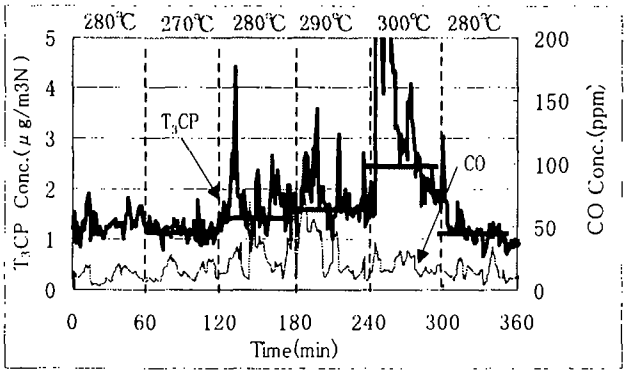


Fig.5 Behavior when varying flue gas temperature

(1) The average T_3CP concentration is high when the gas temperature at the EP entrance rises.

(2) T_3CP concentration increases abruptly and decreases abruptly (spike pattern) just after the set point of the gas temperature at the EP entrance is made high.

The reason for phenomenon (1) seems to be that phenols are easily chlorinated because of rising gas temperature, so the concentration of T_3CP increases. The reason for phenomenon (2) seems to be desorption of T_3CP which is absorbed on the flue or ash on the EP because of rising gas

temperature. The latter phenomenon is considered to be the same phenomenon as the memory effect of dioxins.

We found using the on-line-monitoring system was useful to analyze T_3CP behavior, which differed from that of CO, in some operational conditions of a stoker furnace. By combining various technology to reduce dioxins, the on-line monitoring system will be applicable to operation management in the furnace.

Acknowledgements

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References

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