The estimation and characteristics of PCDDs/DFs emission from the waste incinerators in Korea

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Introduction

Landfill occupied best portion past in waste disposal in Korea, but it was decreased by facing in fundamental limitation of country area. That is, as for trends in ratio of treatment/disposal for municipal solid waste (MSW) in Korea, the recycling and incineration rate increase, while final disposal (i.e. landfill) rate decrease. According to "The second country waste government synthesis plan", occurrence amount of waste is expect to be reduced the quantity by minimization policy. Incineration ratio is increased, especially, is increased to 30% in MSW (municipal solid waste).

But, waste incinerators are presented as main source of persistent organic pollutants (POPs), such as polychlorinated dibenzo-p-dioxins (PCDDs) and polychlorinated dibenzofurans (PCDFs). Incineration condition and waste type affect to PCDDs/DFs emission from final outlet. Accordingly, analysis of dioxin isomer pattern are possible source assumption and contribution analysis etc..

Therefore, in this study, wished to analyze PCDDs/DFs isomer pattern that is exhausted from incinerators' stack using to multivariate statistical technique and estimated interrelationship with incineration condition. As this result, we may estimate incineration condition through isomer pattern analysis of PCDDs/DFs discharged in incinerators.

Materials and Method

Investigation sample of this study was sampled PCDDs/DFs from total 146 incinerators' stacks distributed in Korea. Selected incinerators is consisted of large size incinerator (incineration capacity: more than 2 ton/hr, n =60) and medium size incinerator (incineration capacity: more than 25 kg/hr less than 2 ton/hr, n = 81), small size incinerator (incineration capacity: less than 25 kg/hr, n =5) by incineration capacity, and incineration wastes is medical waste (n =5) and MSW (n = 19), industrial waste (n =122).

PCDDs/DFs in flue gas did sampling in stack that is incinerators' final outlet. Sampling time is more than 4 hours and O₂, NOx, CO and CO₂ measured to interval 5 minutes as air pollutant. Also, we investigated gas moisture component, gas temperature at sampling point and combustion chamber (CC) temperature as incineration condition. Sample was clean-up by sulfuric acid extraction, multi layer silicagel column and alumina column. Sample that pre-treatment is ended analyzed using column (Sp-2331; 60m x 0.32mm x 0.2 μm, Supelco) by HRGC/HRMS (high...
resolution gas chromatograph/ high resolution mass spectrometer; AutoSpec-Ultima, Micromass, UK.

**Result and Discussion**

PCDDs/DFs concentration measured in selected incinerators' stack is 0 ~ 319 ng/Sm³ (avg. 18 ng/Sm³). Incinerator that most high concentration PCDDs/DFs is measured is medium size incinerator of medical waste.

Fig. 1 shows that 2,3,7,8 - substitute isomer (17 kinds) of PCDDs/DFs separated as 4 groups using principal component analysis after normalize. Group 1 (n=66) is consisted of medical waste incinerator (n=1), MSW (n=5), and industrial waste (n=60) according to waste type, and large size incinerators (n=30), medium size (n=35), and small size (n=1) according to incineration capacity, respectively. Group 2 (n=30) is medical waste incinerator (n=1), MSW (n=8) and industrial waste (n=21), and large size incinerators (n=9), medium size (n=20), small size (n=1). Group 3 (n=35) is medical waste incinerator (n=3), MSW (n=1) and industrial waste (n=31), and large size incinerators (n=18), medium size (n=16), small size (n=1). Group 4 (n=15) is MSW (n=5) and industrial waste (n=10), and large size incinerators (n=3), medium size (n=10), small size (n=2).

Concentration and isomer pattern of PCDDs/DFs according to each group arranged to Fig. 2 and Fig. 3, respectively. PCDDs/DFs concentration is 0 ~ 146 ng/Sm³ (avg. 27 ng/Sm³) in Group 1, and ratio of PCDFs and PCDDs is 61 : 39 and dominant isomer is OCDD (21%). Concentration is 0 ~ 15 ng/Sm³ (avg. 3 ng/Sm³) and ratio is 66 : 34 in Group 2 and concentration is 0 ~ 319 ng/Sm³ (avg. 19 ng/Sm³) and ratio 75 : 25 in Group 3. Concentration is 0 ~ 28 ng/Sm³ (avg. 8 ng/Sm³) and ratio is 89 : 11 in Group 4. Dominate isomer in group excepting group 1 is 1,2,3,4,6,7,8-HpCDF (more than 20%).

We did correlation analysis to estimate interrelationship of PCDDs/DFs isomer and incineration condition by each group. Interrelationship of incineration condition is as following with ratio of each group's PCDDs/DFs isomer.

![Fig. 1 Principal component plot of PCDDs/DFs isomer pattern in flue gas from incinerators](image-url)
First, in Group 1, PCDDs/DFs concentration is seen interrelationship (about $r=0.3$) with NOx concentration and standard deviation of CO concentration (for sampling time). Also, 1,2,3,4,6,7,8-HpCDF (21%), OCDF (16%), OCDD (21%) and PCDFs (61%) were interrelationship with oxygen content (%) as $r = 0.3$, $r=-0.3$, $r=0.3$ and $r=-0.4$, respectively. In Group2, 2,3,7,8-TCDD (toxic equivalent factor; TEF=1) was interrelationship with standard deviation of CO concentration as $r=0.4$. In Group3, gas temperature at sampling point and 1,2,3,7,8,9-HxCDD, and standard deviation of CO concentration and 2,3,7,8-TCDD appeared each interrelationship as $r=0.5$ and $r=0.4$. In Group4, 1,2,3,4,6,7,8-HpCDD was interrelationship with CO's concentration as $r=0.6$.

**Conclusion**

PCDDs/DFs isomer patter from incinerator's stack is separated as 4 groups using principal component analysis. Interrelationship appears to differ with PCDDs/DFs isomer pattern and incineration condition according to each group. In general, PCDFs is higher than PCDDs and highly chlorinated PCDDs/DFs compounds were high. Dominate isomer according to group is 1,2,3,4,6,7,8-HpCDF and OCDD, and emission ratio of PCDDs/DFs isomer was interrelationship with oxygen content (%), standard deviation of CO concentration, gas temperature at sampling point, and CO's concentration as incineration condition (more than $r=0.3$).

**Reference**


