LEVELS OF PCDD/FS IN AMBIENT AIR DURING THE TRIAL BURNS OF A MUNICIPAL SOLID WASTE INCINERATOR IN TAIWAN

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Introduction

A Taiwanese generates an average of 1.14 kg of waste every day. The whole nation generates a daily average of 24000~25000 metric tons of waste. The lack of landfill sites has made the Government to select incineration as the major means of waste treatment. The Executive-Yuan has pushed the project of constructing municipal solid waste incinerators (MSWIs) in Taiwan on 1991. A total of 21 large MSWIs are anticipated to be in operation by the end of 2002. The daily treatment capacity will be 21,900 metric tons of waste generated by 16 million people. There are currently 12 MSWIs in operation and one MSWI under retrofitting work.

The public has heavily concerned the emission of dioxins from MSWIs. The protest from local residents against the construction of new MSWIs usually comes from the worry about dioxin risk. To relieve the public from the fear of dioxin, the Government started to monitor dioxin content in ambient air, soil, plant, and residents' blood in the vicinity of 5 MSWIs per year. However, the lack of baseline data, i.e. those before the operation, prevents the comparative study of the environmental impact by the constructing MSWI. This deficiency might also make the settlement of future request for damage compensation by dioxin emission being difficult.

HsinChu MSWI is located on the seashore. It has three incineration lines, each with a daily capacity of 300 metric tons. The APCD (air pollution control device) consists of lime plus activated carbon (AC) injection, a semi-dry scrubber (SDS), and a bag-house filter (BF). The present paper focuses on the monitoring of PCDD/Fs in ambient air prior to the operation of the MSWI and during the trial burns.

Methods and Materials

A total of 10 samples evenly distributed through the city were collected and analyzed. Figure 1 depicts the sampling sites. The flag represents where the MSWI locates. Sampling point A, C, E, F, H, and J is school, B is government agency, D and G is resident area, I is on the seashore. The two concentric circles represent a radius of 2.5 and 5 km, respectively. The samplings started on the end of March 2001 and lasted two weeks. The 10 samples were collected during a two-week period. The wind blows in the northeastern direction during the sampling period. We followed the US EPA Compendium Method TO-9A "Determination of Polychlorinated, Polychorinated and Brominated/Chlorinated Dibenzo-*p*-dioxins and Dibenzofurans in Ambient Air" for sampling and analysis. The samples were collected using a Graseby-Anderson PS-1 using a glass fiber filter followed by a polyurethane foam (PUF) plug. The samplers were located on the roof of a two(or three)-story building.

The samples were extracted in 300 ml toluene for 24 hours followed by rotary evaporation and multi-step multi-column clean-up procedure. HRGC/HRMS analyses were carried out at a 10,000 mass resolution on a VG AutoSpec Ultima coupled to a HP 6890 GC system using a 60-m DB5-MS column.

Results and Discussion

The dioxin levels in the ambient air samples expressed using Internal Toxic Equivalent Factors (I-TEF) are listed in Table 1. They range from 0.056 pg-TEQ/m^3 to 0.123 pg-TEQ/m^3 with an average value of 0.085 0.123 pg-TEQ/m^3. The circles shown in Figure 1 represent the dioxin levels. The larger the circle is the higher the dioxin level in the corresponding ambient air. The highest dioxin level was found in sampling point H, where there is a near-by industrial park. The congener profiles are similar for all sampling points, except H. A comparative inspection of the congener profile shown in Figure 1 indicates that higher levels of 1,2,3,7,8,9-HxCDD, 1,2,3,4,6,7,8-HpCDD, and OCDD were present in the H sample. The sources of these congeners are still under study. The dioxin level appears to reduce along the northeastern direction. The highest dioxin level was found for A, B, C, and D points, meddle dioxin level was found in E, F and G points, the lowest dioxin level was found for I and J points. This trend is attributed to the heavy industrial activities on the northeastern surrounding of Hsinchu city.

Fiedler has reported annual mean values of PCDD/F for ambient air in German on 1993[1]. They are 0.025~0.070 pg-TEQ/m^3 for rural area, 0.070~0.350 pg-TEQ/m^3 for urban area, and 0.350~1.600 pg-TEQ/m^3 for close to source points. The average dioxin level found in this study falls in the urban area category of Fiedler study. However, dioxin level from sampling points E and J fall in the rural area category. Sampling point E is close to the incinerator and near the seashore. The sea-wind blows into the land during the night might reduce some dioxin level in the air. Sampling point J locates in a hill area, where little industrial and human activities are observed.

Takei et al., have reported the averaged PCDD/F concentration in Japan air from 1988[2]. They are 0.25 pg-TEQ/m^3 for the vicinity of incinerators, 0.21 pg-TEQ/m^3 for large cities, 0.18 pg-TEQ/m^3 for medium/small cities, and 0.25 pg-TEQ/m^3 for background. The average dioxin level found in this study (0.085 pg-TEQ/m^3) is lower than the 0.18 pg-TEQ/m^3 for similar medium/small cities in Japan.

Coutinho et al., have measured the atmospheric levels of PCDD/F before the operation of the MSWI and during the test phase of the MSWI[3]. They are 0.167 pg-TEQ/m^3 for the baseline period, 0.210 pg-TEQ/m^3 during the test period, 0.125 pg-TEQ/m^3 during the Spring-Summer time, and 0.247 pg-TEQ/m^3 during the Autumn-Winter time. The National Institute of Environmental Analysis has conducted a similar but limited study on February 2001[4]. They measured the dioxin level in ambient air from sampling points A, B, and E. The average value is 0.267 pg-TEQ/m^3, which is about three times of the average value from this study is 0.093 pg-TEQ/m^3. This ratio agrees with the Coutinho' study. The results imply the comparison of ambient air monitoring results should be based on the same reason.

PCDD/F levels measured in the ambient air during the trial burns of the Hsinchu MSWI were relatively low with an average value corresponding to the urban area. Higher dioxin levels were found during winter. A systematic decrease of PCDD/F in the ambient air from the northeastern

area was observed. The contribution from the MSWI to the dioxin levels in the ambient air of Hsinchu city is regarded insignificant. More research is needed to prove the presumption that the northeastern industrial area contributes significantly to the local dioxin levels.

Acknowledgements

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References

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2. Takei, T., Araki, S., Kauai, M. and Morita, M. (2001) Organohalogen Compounds 46, 475.
3. Coutinho, M., Ferreira, J., Gomes, P. and Borrego, C. (2001) Organohalogen Compounds 46, 447.
4. Chinatimes (2000) Incinerator emits dioxin, the results said. 9th June. Hsinchu local news.

Table 1. Dioxin levels in the ambient air for each sampling site (pg-TEQ/Nm^3)

Site	A	B	C	D	E	F	G	H	I	J
2,3,7,8-TeCDF	0.002	0.002	0.002	0.002	0.001	0.002	0.002	0.002	0.002	0.002
1,2,3,7,8-PeCDF	0.003	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.001
2,3,4,7,8-PeCDF	0.050	0.034	0.037	0.031	0.025	0.031	0.035	0.035	0.027	0.021
1,2,3,4,7,8-HxCDF	0.011	0.009	0.009	0.007	0.006	0.008	0.009	0.008	0.007	0.005
1,2,3,6,7,8-HxCDF	0.009	0.007	0.007	0.006	0.005	0.006	0.007	0.007	0.005	0.004
2,3,4,6,7,8-HxCDF	0.015	0.011	0.011	0.009	0.006	0.009	0.010	0.009	0.007	0.006
1,2,3,7,8,9-HxCDF	0.004	0.003	0.003	0.003	0.002	0.002	0.003	0.003	0.002	0.002
1,2,3,4,6,7,8-HpCDF	0.004	0.004	0.003	0.003	0.002	0.003	0.003	0.003	0.003	0.002
1,2,3,4,7,8,9-HpCDF	0.001	0.001	0.000	0.000	0.000	0.000	0.001	0.000	0.000	0.000
OCDF	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2,3,7,8-TeCDD*	0.004	0.003	0.003	0.003	0.002	0.003	0.002	0.004	0.002	0.002
1,2,3,7,8-PeCDD	0.011	0.006	0.009	0.007	0.006	0.006	0.008	0.010	0.006	0.005
1,2,3,4,7,8-HxCDD	0.002	0.001	0.002	0.002	0.001	0.001	0.002	0.003	0.001	0.001
1,2,3,6,7,8-HxCDD	0.004	0.003	0.004	0.003	0.002	0.003	0.004	0.004	0.002	0.002
1,2,3,7,8,9-HxCDD	0.003	0.002	0.003	0.003	0.001	0.002	0.003	0.004	0.002	0.002
1,2,3,4,6,7,8-HpCDD	0.002	0.002	0.003	0.002	0.001	0.002	0.003	0.007	0.001	0.001
OCDD	0.000	0.000	0.001	0.001	0.000	0.000	0.001	0.005	0.000	0.000
Total	0.127	0.090	0.101	0.084	0.063	0.080	0.095	0.107	0.070	0.058

* Estimated value

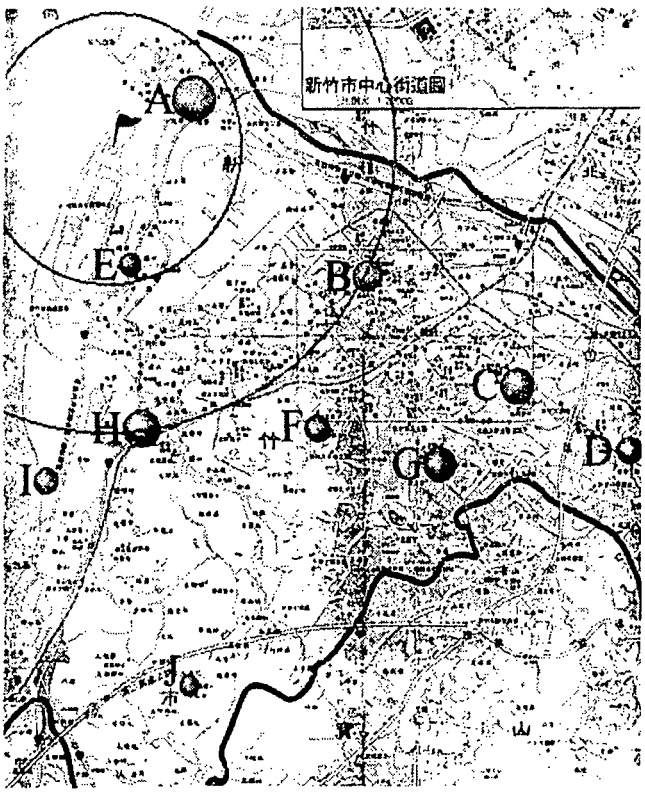

Figure 1. The sampling points and the dioxin levels in the corresponding ambient air

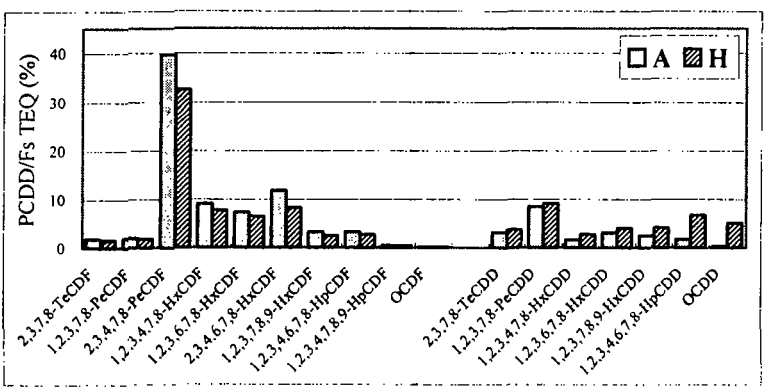

Figure 2. Congener profiles of ambient air sample from point A and H