GAS-PARTICLE PARTITIONING AND CONCENTRATION OF DIOXINS/FURANS IN ATMOSPHERE OF KOREA

Jong-Guk Kim[1], Jin-Soo Park[2]

Department of Environmental Engineering Chonbuk National University[2],
Research Institute of Industrial Technology in Chonbuk National University[1]
664-14 Duckjin-Dong Duckjin-Gu Chonju Chonbuk, 561-756 Korea

Introduction

Polychlorinated dibenzo-*p*-dioxins and dibenzofurans(PCDD/PCDFs) are derived from a variety of combustion processes; municipal and industrial waste incinerator, automobiles, and steel mill. PCDD/PCDFs emitted from these sources contaminate ambient air, and then disappear from the atmosphere by dry/wet deposition and photolysis. This indicates that the concentrations of PCDD/PCDFs in atmosphere are closely related to artificial factors of some regions such as those of industrialization, population, and also the fate to partition between gaseous and particulate phases. In general, partitioning coefficient between gaseous and particulate phases is expressed as $K_p=(C_p/TSP)/C_g$. Pankow reported that partitioning coefficient was related to the surface area of the particle and vapor pressure of pollutant. In order to observe the fate of PCDD/PCDFs in the atmosphere, the concentrations of PCDD/PCDFs according to scale and usage of regions and the partitioning coefficient to vapor pressure and temperature was investigated.

Material and method

Sampling location: To investigate the concentrations of PCDD/PCDFs according to scale and usage in regions, 21 samples were obtained; Ambient air samples was classified into small, medium-size and large city according to city-scale and into residential, also commercial and industrial area to city-usage. To investigate partition gaseous and particulate phases, 9 of 21 samples were separated with a filter and into PUF. Sample information is shown Table 1.

Table 1. Sample information

	small-city [a]		medium-sized-city [b]		large-city [c]	
	n	temp.(℃)	n	temp.(℃)	n	temp.(℃)
residential	3	4.4	4	18.2	2	15.2
commercial	2	8.6	1	23.6	2	14.8
industrial	2	7.5	3	21.3	2	16.4

[a] : where population is more than one million.
[b] : where population is more than three hundred thousand.
[c] : where population does not exceed three hundred thousand.

Sub-cooled liquid vapor pressure(P_l): The vapor pressures of congeners using $\log P_L = A_{pl} - B_{pl}/T$ as Clausius-Clapeyron equation was calculated according to temperature, A_{pl} and B_{pl} was referred to Jaakko Paasivirta.[1)]

Result and discussion

Ambient air concentration by city-scale: the concentration of PCDD/PCDFs in atmosphere by city-scale is shown figure 1. The mean value for the large-city was 0.593 pg-TEQ/Nm^3, medium-sized-city was 0.244pg-TEQ/Nm^3, and that of the small-city was 0.122pg-TEQ/Nm^3. On the actual condition investigated by The Korea National Institute of Environmental Research, the concentration for the large-city was similar to that of the research which was 0.598pg-TEQ/Nm^3. The concentration of medium-sized-city was similar to that of large-city which was 0.22pg-TEQ/Nm^3 in Japan.[2)] The concentration of large-city was higher than that of medium-sized-city by twice and that of small-city by five times. In overall, there was a great difference in concentration between regions of medium-sized-city.

Ambient air concentration by city-usage: The concentration of PCDD/PCDFs in atmosphere by city-usage is shown figure 2. The concentration for residential area which was 0.20pg-TEQ/Nm^3 was the lowest level of the various areas, commercial area was 0.31pg-TEQ/Nm^3, and that of the industrial area was the highest-0.43pg-TEQ/Nm^3.

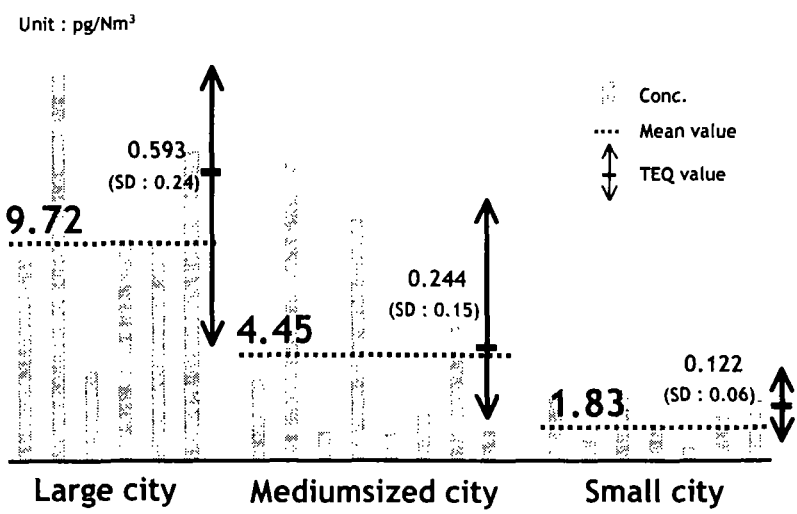

Figure 1 Total and TEQ level of PCDD/PCDFs by city-scale

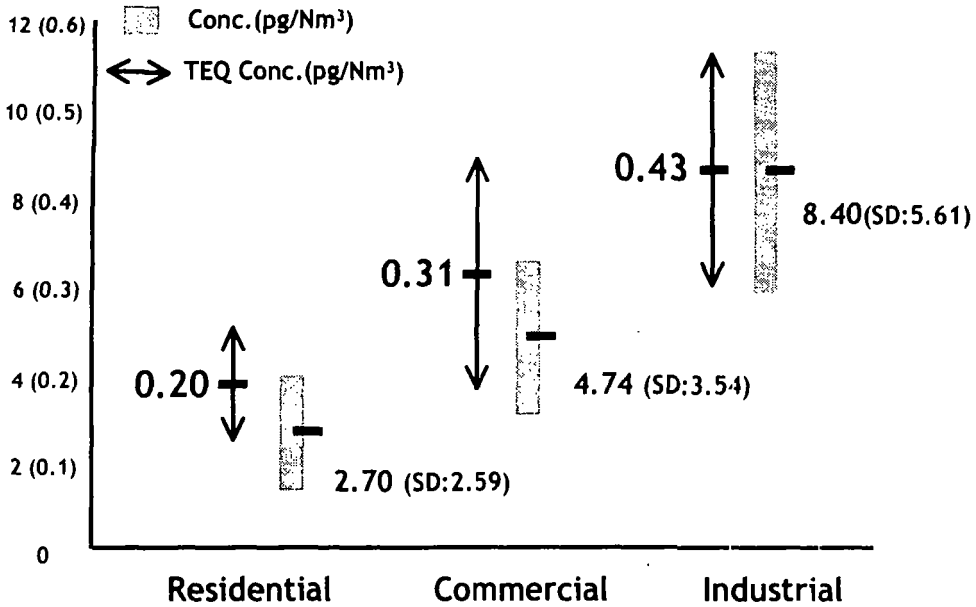

Figure 2 Total and TEQ level of PCDD/PCDFs by city-usage

Particle-Vapor partitioning: The K_p value is widely used to investigate particle-vapor partitioning. The Relationship between vapor pressure and K_p is shown in figure 3. From the chart, we can see that figure 3 is further subdivided into residential, commercial, and industrial area. The slope of the plot is -0.6869 ~ –0.5838 and the intercept is –4.4042 ~ -3.7752. The slope and intercept of the plot according to areas made a little difference. For OC compounds, Kaupp and Umauf reported that the slope was -0.61 and the intercept was –4.74. [3)]

The particle-vapor partitioning of homologue according to temperature was that the partitioning coefficient (K_p) of PCDD/PCDFs increased as temperature decreased. The dominant congeners of PCDD/PCDFs in particle were high-chlorinated compounds. And because of that, it was thought that most of high-chlorinated compounds are moved to the environment through particles.

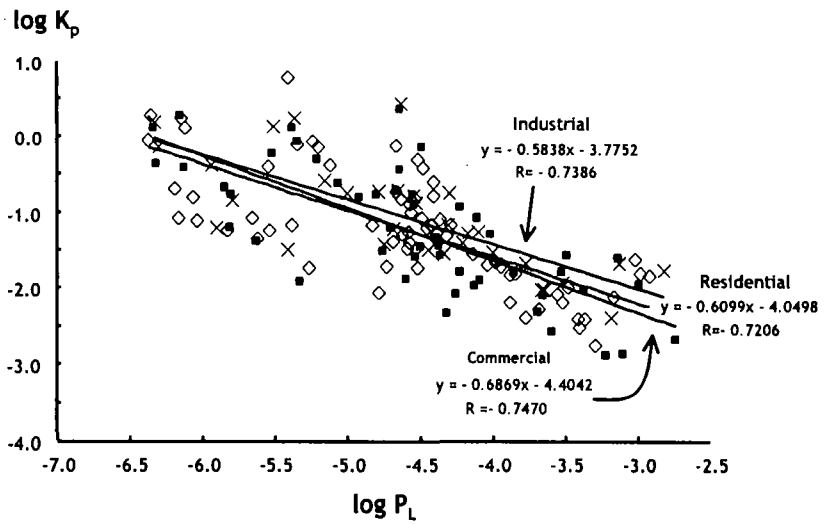

Figure 3. Relationship between K_p and P_L

Acknowledgements

This work was supported by grant No.2000-2-30900-002-3 from the Basic Research Program of the Korea Science & Engineering Foundation.

References

1. Jaakko Paasivirta, Seija Sinkkonen, Pirjo Mikkelson, Tiina Rantio and Frank Wania(1999) Chemosphere, Vol. 39 No. 5, 811
2. Teiji Takei, Shinnichi Araki, Masatoshi Kanai, Masatoshi Morita (2000) Organohalogen Compounds Vol. 46, 475
3. Kaupp,H and Umlauf, G(1992) Atmospheric Environment, 26A, 2259