

## BEHAVIOR OF PCDDs/DFs IN WET SCRUBBER SYSTEM OF MUNICIPAL SOLID WASTE INCINERATION PLANT

Sung-Yong Kim, Man-Six Yoo\*, Geon-Heung Kim\*\* and Gon Ok

Faculty of Earth Environmental Sciences and Dioxin Research Center, Pukyong National University, Busan 608 - 737, Korea

\* Environmental Management Corporations, Seoul 135-812, Korea

\*\* Department of Civil Engineering, Inha University, Incheon 402-751, Korea

### Introduction

Incineration has been used as an economical technique reducing of solid wastes from industrial and municipal activities as well as producing thermal energy. The large-scaled incineration plants of total 53 facilities in constructing in Korea and MSWI of nine plants were already operating<sup>1</sup>. Many authors reported that combustion process from MSWIs was the main source of PCDDs/DFs in the environment<sup>2-3</sup>. Two-thirds of them were equipped with Electrotatic precipitator (EP) and wet scrubber (WS) systems, to diminish air pollutants in gas and particulate matter into atmosphere. Accordingly, the emission guideline was set at 0.1 ng-TEQ/Nm<sup>3</sup> for the large MSWIs by government<sup>4</sup>. Removal of PCDDs/DFs has been investigated in two system by numerous workers<sup>5-6</sup>. Therefore, the objective of this paper is to investigate behavior of PCDDs/DFs in circulation water of wet scrubber from MSWIs according to the addition of activated carbon over time.

### Materials and Method

The circulating water sampled at one MSWIs with treatment capacity above 200 ton/day. The samples were sampled from wet scrubber at the intervals of 0, 1, 2, 4, 24 hours to investigate in particle and liquid phase. The Particle portion was isolated by filtration through glass fibers filters (GFF, whattman) of 47 mm, and then dried at room temperature. The particle sample was extracted using a Soxhlet apparatus with toluene for 24 hours. The fraction of liquid phase was liquid-liquid extracted with toluene. The particle and liquid samples were transferred to *n*-hexane. After pre-cleaned up with multi-layer silica column containing AgNO<sub>3</sub>-silica gel, H<sub>2</sub>SO<sub>4</sub>-silica gel, and KOH-silica gel, the extract was cleaned up on activated neutral alumina column with successive elutants of 3% methylene dichloride in *n*-hexane and 50% methylene dichloride in *n*-hexane. The second fraction was concentrated to less than 1 mL. HRGC/HRMS was operated at resolution higher than 10,000 to quantity PCDDs/DFs in water samples. Detailed experimental procedures and instrumental analyses for PCDDs/DFs were previously reported paper<sup>7-8</sup>.

### Results and Discussion

#### *Variation of PCDDs/DFs concentration at wet scrubber system*

PCDDs/DFs concentrations in particle phase of water samples from 1st wet scrubber varied from 781 to 3,315 pg-TEQ/L and ranged between 0.1 and 68 pg-TEQ/L in liquid phase. For 2nd wet scrubber, PCDDs/DFs level were in the range of 75 – 1,494 pg-TEQ/L for particle phase and were in the range of 0.1 - 0.4 pg-TEQ/L for liquid phase. PCDDs/DFs concentration in water samples from 1st wet scrubber was 2-3 times higher than these from 2nd wet scrubber system. This experimental result was because the flue gas was preferentially passed in 1st wet scrubber, and

then went through 2nd wet scrubber system. PCDDs/DFs detected at liquid fraction of water samples from 1st and 2nd wet scrubbers were neglected in comparison with those of particle portion. The variation of PCDDs/DFs concentrations in water samples from wet scrubber system over time is presented in Fig. 1. Variation of PCDDs/DFs in two wet scrubber system showed a similar pattern. Maximum concentration was found at the sample of 2 hours at 1st system and 4 hours at 2nd system. The PCDDs/DFs concentration increased to 4 hours and decreased at 24 hours. This seems that PCDDs/DFs in wet scrubber system was treated by adsorption of activated carbon added.

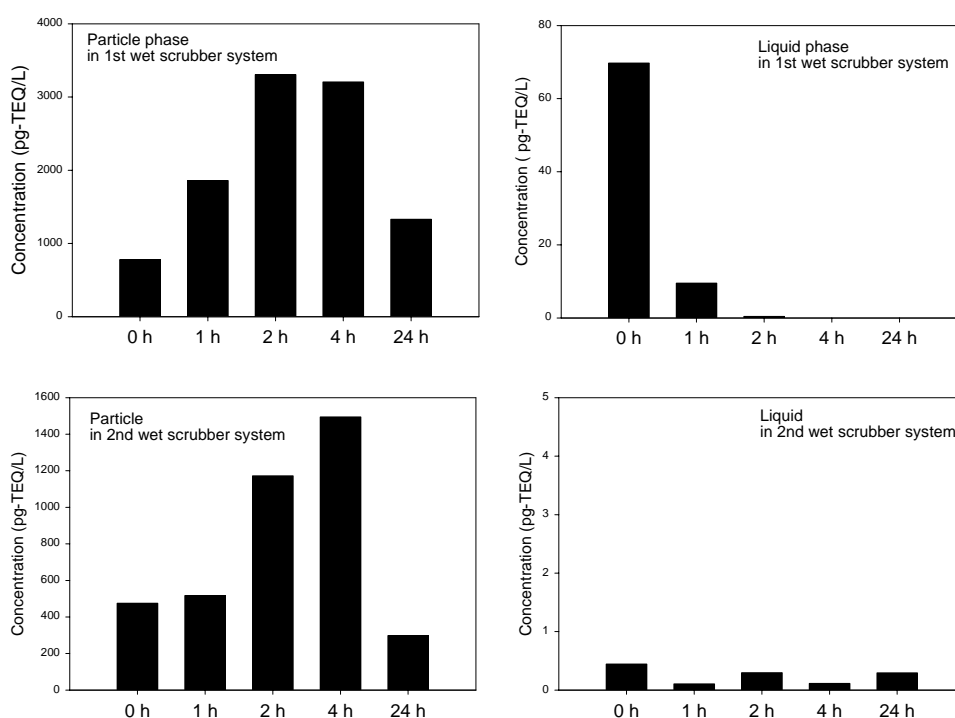


Fig.1. Variation of PCDDs/DFs in particle and liquid-phase in wet scrubber system.

#### *Homologue profiles of PCDDs/DFs*

Homologue profiles of PCDDs/DFs in particle phase from two wet scrubbers dominated by hepta- and octa-CDD in PCDDs. Hexa- and hepta-CDFs were the predominant species in PCDFs<sup>9-10</sup>. These pattern of PCDDs/DFs profiles were a typical pattern in flue gas from MSWI of Korea<sup>11</sup>. There were no variation of PCDDs/DFs homologue in water samples from wet scrubber over time in particle phase<sup>5</sup>. However, in the case of liquid phase, the lower chlorinated PCDDs/DFs was removed by the addition of activated carbon.

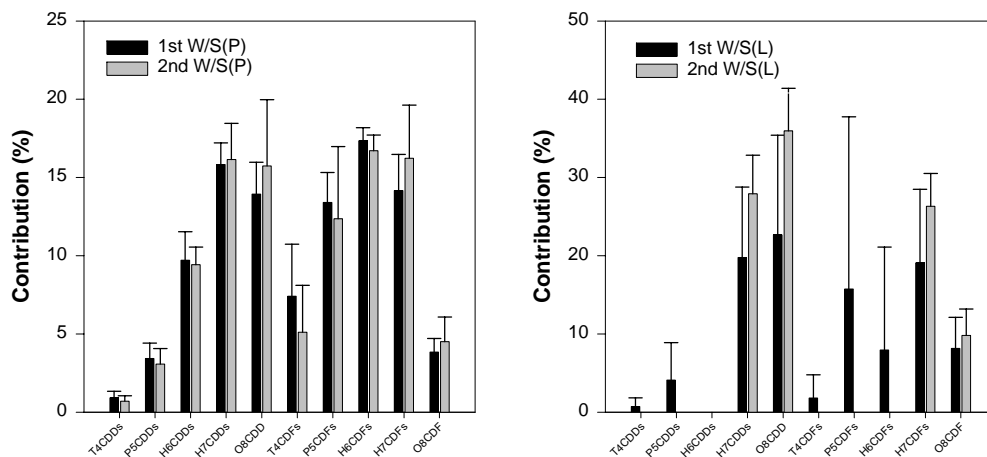


Fig.2. Homologue profiles of PCDDs/DFs in particle and liquid phase in wet scrubber.

Principal component analysis (PCA) was carried out as variables of 2,3,7,8-substituted PCDDs/DFs, to investigate the distribution according to both two phases in wet scrubber (Fig. 3). PC 1 (51%) was correlated with most of the particle phase, while the second PC 2 (33% of the variance) was correlated with the liquid phase. B plot is presented first main PC (which would explain 58%) is correlated with most of PCDDs/DFs congener excepted 1,2,3,4,6,7,8-hepta D/F, 1,2,3,4,7,8,9-heptaCDF and OCDD/F.

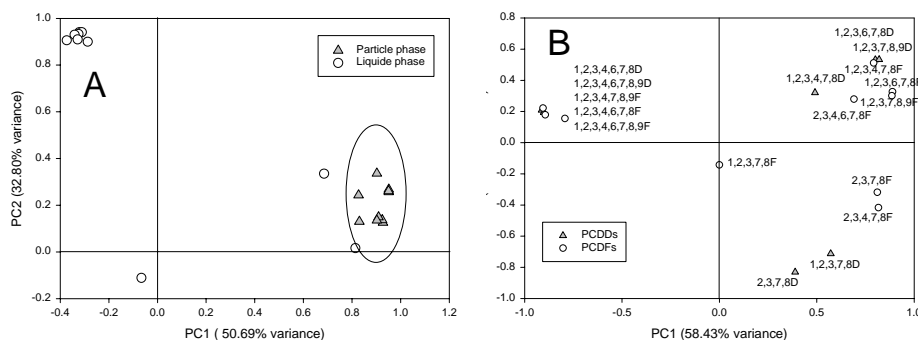


Fig.3. The plot of PCDDs/DFs distributions in particle and liquid phase by PCA from water samples in wet scrubber. (A): each particle and liquid phase was used as variables. (B): each 2,3,7,8-substituted PCDD/DF was used as variables.

*References*

1. Ministry of Environment, Republic of Korea (1998) Environmental White Book, 486.
2. Domingo, J.L., Schuhmacher, M., Lobet, J.M., Muller, L., and Rivera, J. (2001) *Chemosphere* 43, 217-226.
3. Schuhmacher, M., Granero, S., Rivera, J., Muller, L., Liobet, J.M., Domingo, J.L. (2000), *Chemosphere* 40, 593-600.
4. Ministry of Environment, Republic of Korea (1996) The Korean standard testing method of dioxins and furans.
5. Kreizu, S., Hunsinger, H. and Vogg, H. (1996), *Chemosphere* 32, 73-78.
6. Sierhuis, W.M., De Vries, C and Born, J.G.P. (1996) *Chemosphere* 32, 159-1681.
7. Ok, G., Moon, H.B., Ji, S.H. and Han, Y.H. (1999) *Organo. Comp.*, 43, 209-212.
8. Ok, G., Kim, Y.K., Kim, S.J., Ji, S.H., Moon, H.B., Kim, Y.S., Lee, D.I. and Han, Y.H. (2000) *Organo. Comp.*, 45, p.328-331.
9. Ok, G., Hanai, Y, and Katou, T (1991), *Chemosphere*, 23, 1287-1294.
10. Ok, G., Hanai, Y, and Katou, T (1993), *Chemosphere*, 26, 2167-2172.
11. Ok, G., Suk, H.J., Ji, S.H. Moon, H.B. and Lee, H.H.(1998), *J. Kor. Environ. Anal.*, 1, 33-40.