PCDD/DFS AND dl-PCBS FROM SEWAGE DISPOSAL FACILITIES IN KOREA

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Introduction

Sewage sludge from a sewage disposal facility contains more than 300 kinds of organic substances as residual products[1], which have different physical and chemical characteristics from one another and the extent of concentration differentiates according to the characteristics of the disposal sources[2,3]. In various organic chemical substances from sewage sludge, persistent organic pollutants (POPs) are included, which are toxic, persistent, bio-accumulative, and capable of long-range transfer. Dioxin-like compounds have been reported to be carcinogenic, mutagenic and toxic in mammalian systems, including humans [4].

Dioxin-like compounds (polychlorinated dibenzo-p-dioxins; PCDDs, polychlorinated dibenzofurans; PCDFs, dioxin-like polychlorinated biphenyls; dl-PCBs) from sewage disposal facilities are known to flow in through various paths, such as from a wastewater disposal plant, urban runoff , a wet or dry deposition, and household disposal water[5]. Particularly for household disposal water, the inflow of PCDD/DFs produced by laundry washing and bathing has been reported to be the largest, the source of which is assumed to be the PCDD/DFs discharged in the cloth bleaching process[6,7].

This study aims to have a thorough grasp of the distribution of concentration and the emission characteristic of dioxin-like compounds in the effluent and sewage sludge from sewage disposal facilities and estimate amount of the dioxin-like compounds released to the environment by each pathway.

Materials and Methods

Five sewage disposal facilities were examined to see the distribution of concentration and the estimation amounts of dioxin-like compounds from the sewage disposal facilities. Samples were collected in the effluent, which came out of the 5 sewage disposal facilities operating in September, 2003. More specifically speaking, sewage sludge was collected twice, in March and September, 2003. Fig. 1 presents the sewage and sludge sampling sites.

The samples were clean-up and analysis methods of the dioxin-like compounds by HRGC/HRMS (Ok et al, 2002). HRGC/HRMS analysis was performed using a HP 6890 GC coupled to a JEOL JMS-700D HRMS at a resolution of over 10,000(10 % valley) in selected ion monitoring mode (SIM).

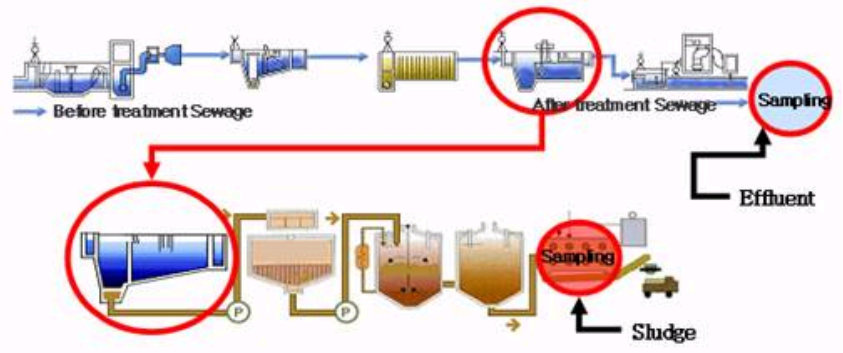

Figure 1. Sampling sites from sewage treatment facilities in this study.

Result and Discussion

Effluent - The concentration distribution of the effluent is N.D.-278 pg/L for PCDD/DFs, N.D.-123 pg/L for dl-PCBs, and N.D.-2.72 pg WHO-TEQ/L (All WHO-TEQ concentration include dl-PCBs). The result shows that the effluent of the B facility has the highest WHO-TEQ concentration. Fig. 2 presents the comparisons of the total WHO-TEQ concentrations and that of each facility. PCDD/DFs homologue from the examined effluent was extracted from the most representative industrial areas of the city, only the B and E facilities. The concentration of dl-PCBs was dominated by the industrial facility B.

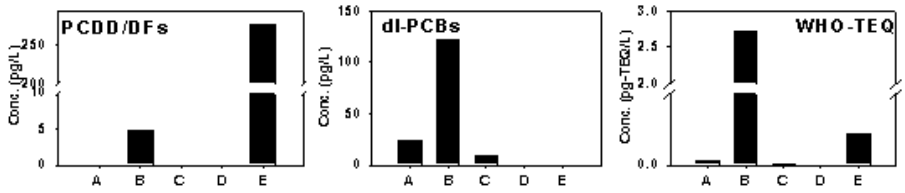

Figure2. Total concentration of PCDD/DFs, dl-PCBs and WHO-TEQ in effluent from each facility.

Sludge - Sewage sludge was collected twice, in March and September. The concentration range of PCDD/DF homologues from the 1st sludge was 0.94-38.8 /kg d.w. and that of dl-PCBs was 1.22-23.0 /kg d.w. respectively. WHO-TEQ concentration was 3.86-736 ng WHO-TEQ/kg d.w.. The concentration range of PCDD/DF homologues from the 2nd sludge was 1.06-21.1 /kg d.w. and that of dl-PCBs was 0.48-9.47 /kg d.w. The WHO-TEQ concentration was 2.73-259 ng WHO-TEQ/kg d.w.. Fig. 2 shows the concentration of PCDD/DFs, dl-PCBs, and WHO-TEQ from each facility.

As presented in Fig. 3, the concentrations of PCDD/DFs and WHO-TEQ from the D facility were the highest and the dl-PCBs from the B facility were the highest. The concentration of PCDD/DF homologues from the effluent in the D facility was N.D. but the highest in the sewage sludge. WHO-TEQ concentration was dominated in the B and D facilities.

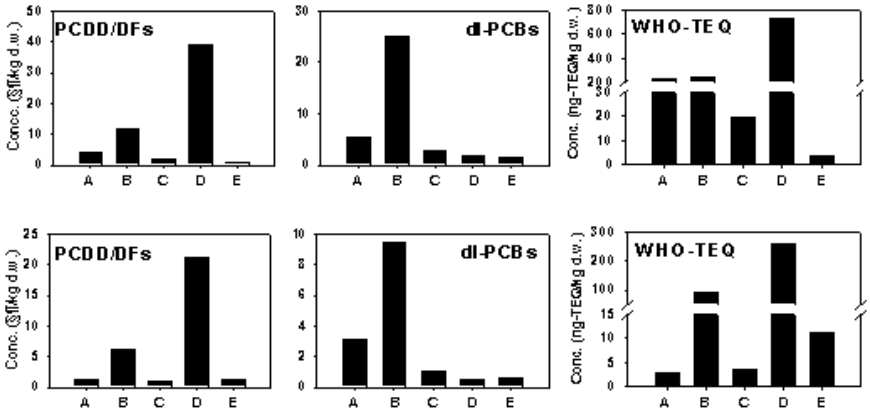

Figure 3. Total concentration PCDD/DFs, dl-PCBs, and WHO-TEQin the first sewage sludge (top) and the second sewage sludge (bottom) from each facility.

Figure 4 presents the profile pattern of the PCDD/DF homologues and the dl-PCBs congener. According to the results of this study, the rates of the PCDD homologues were quite similar but those of the PCDF were higher than in other studies.

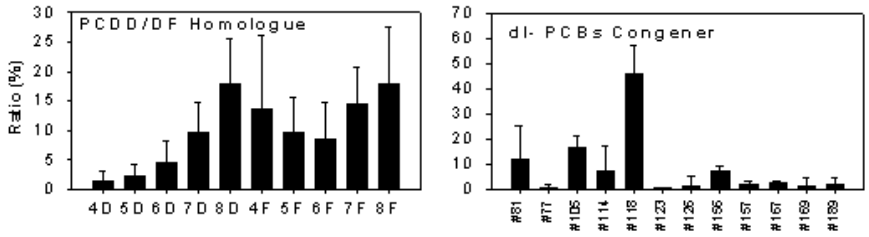

Figure 4. Ratio of PCDD/F homologues (left) and dl-PCB congeners (right) in sludge.

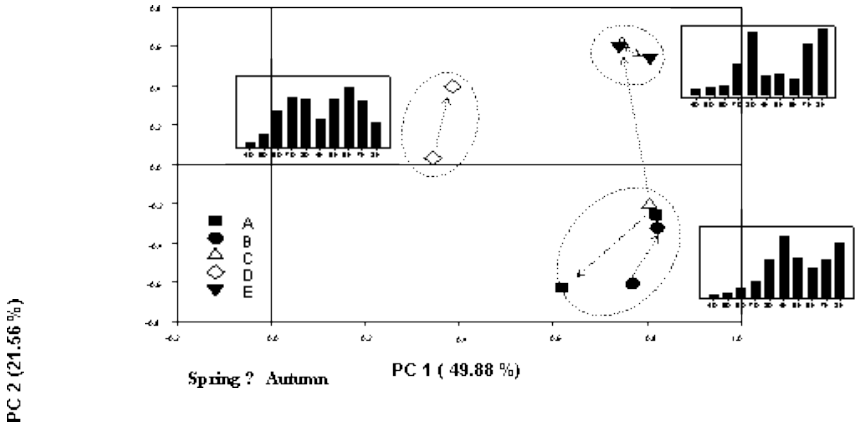

Figure5. Principal component analysis of PCDD/DF homologues in influent sewage from sewage disposal facilities.

Fig. 5 presents the results of principal component analysis to research the characteristics of PCDDs/DFs from the sewage sludge. The samples of the A, B and C (spring) facilities and the samples of the C (autumn) and E facilities followed the same patterns respectively while the D facility followed another independent pattern.

Emission amounts of dioxin-like compounds from the sewage disposal facilities were estimated to be approximately 334 g WHO-TEQ/yr, based on the emission factor and activity. The emission amount of dioxins from sewage sludge was almost 99 %. Dioxins emissions amount out to the ocean or the nearest river came up to 266.6g WHO-TEQ/yr while that of the incineration process 0.10g WHO-TEQ/yr, the discharging process to the land, as a fertilizer, landfill and etc, 42.35g WHO-TEQ/yr, and the other processes 24.58g WHO-TEQ/yr. Fig. 6 presents the emission amount ratio of the effluent and sludge.

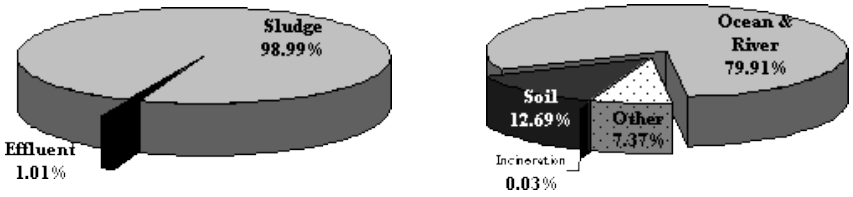

Figure 6. Estimation of dioxins emission from sewage disposal facilities in Korea.

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