THE CHARACTERISTICS AND THE LEVEL OF PBDEs IN EFFLUENT DISCHARGED FROM THE SEWAGE TREATMENT FACILITIES TO AN ENVIRONMENT IN KOREA

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Introduction

PolybrominatedDiphenyl Ethers (PBDEs) are the brominated flame retardant widely used in building materials, plastics, electronics, furnishings, motor vehicle, textiles and more. Due the worldwide usage of PBDEs, PBDEs is considered as ubiquitous environmental contaminants that are commonly detected in the environment. There are 209 PBDEs congeners with 10 isomers, depending on the number of bromide attached to the benzene ring. PentaBDE, octaBDE and decaBDEs are the compounds that are commonly contained in commercial products (1). The most dominant congener in pentaBDE, octaBDE and decaBDE are BDE99, BDE183 and BDE209, respectively. In 2009, some PBDEs compounds such as tetraBDE, hexaBDE and heptaBDE were listed as new persistent organic pollutants (POPs) by the Stockholm convention (2). Sewage treatment effluents have been suggested as a major source of PBDE contamination in environment surrounding the site of discharge (3). The major congeners of commercial PBDE mixtures such as pentaBDE mixtures have been measured from the effluent discharged from the sewage treatment facilities in North America (4,5,6). In order to properly manage the PBDEs pollution in the environment caused by the sewage treatment processes, it is important to have a clear understanding of the amount and characteristics of PBDEs released to environment.In present study, the amount of PBDEs released to the environment from the sewage treatment facilities in Korea, and their characteristics have been identified.

Materials and methods

The estimated total flow rate of sewage in Korea is approximately 16,681,388 m^3/day. Furthermore, the total sewage sludge generated nationwide is estimated to be 2,539,532 ton/year (7). The survey conducted by the ministry of environment suggests that the sea dumping contributes the most to the sludge generation (1,394,528ton/year), followed by landfill (104,004ton/year) and recycle (533,681ton/year) (7). In present study, the Korea was divided into 4 different areas: Capital area, Chungcheong area, Honam area and Yeongnam area. The influent that has not been treated and the effluents produced after the sewage treatment were collected from the sewage treatment facilities in these four areas.

The particulate matters and dissolved matters in the influents and effluents were separated by filtration using Glass microfiber filters (Whatman, UK). The particulate matters were frozen dried and extracted for 16 hours using soxhlet with Toluene. The dissolved matters were liquid-liquid extracted with toluene three times. The conversion of the solvent in the extract was held from toluene to n-hexane. The extracted sample dissolved in n-hexane was then inserted with 0.5ng of internal standard (BFR-LCS, Wellington).

The clean-up process of the extract was conducted with a multilayered silica gel column consisting of 2 g of anhydrous sodium sulfate, 0.2 g of silica gel, 0.75g of KOH, 0.2 g silica gel, 1 g of 44% of H2SO4, 1g of 22% H2SO4, 0.2 g of silica gel, 2 g of 10% AgNO3 and 2 g of anhydrous sodium sulfate. The elution was held with 100mL of 10% Dichloromethane/n-hexane. For PBDEs analysis, the labeled standard and the internal standard solutions (BFR-LCS, Wellington and BFR-ISS, Wellington Laboratories Inc.) were spiked. The instrumental analysis of PBDEs was conducted with gas chromatography/High Resolution Mass Spectrometry (HP 6890/JMS 700D). The capillary column used for PBDEs analysis was DB-5MS (15m×0.25mm×0.1㎛) (8).

Results and discussion

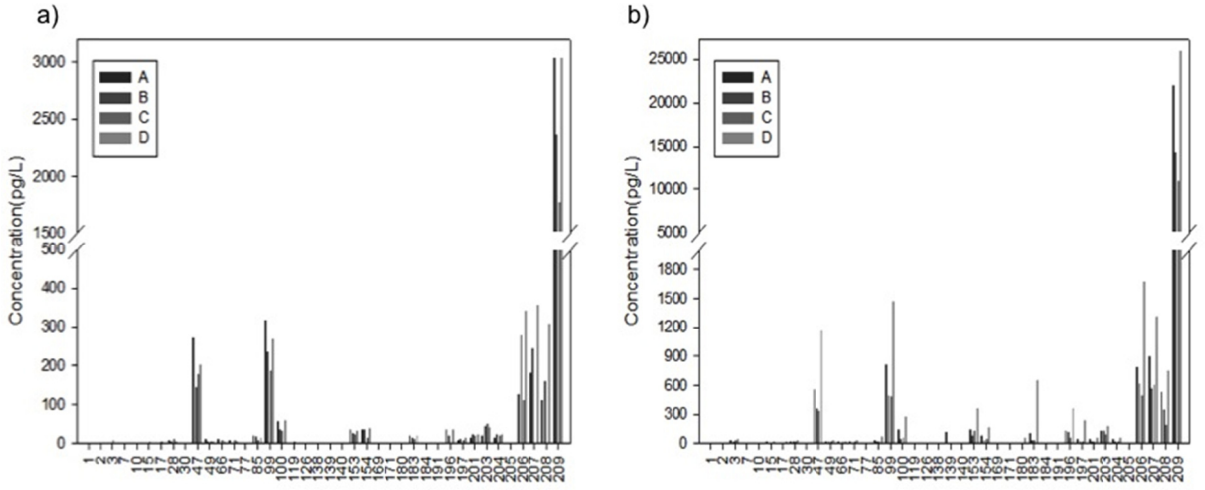

Figure 1. Profile pattern of PBDEs in raw sewage at **a)**dissolved phase and **b)**particulate phase

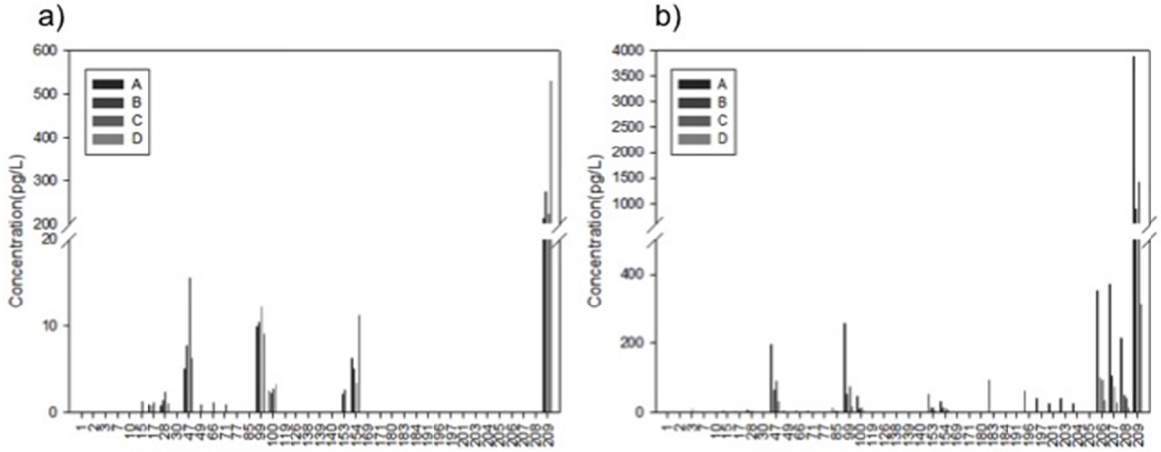

Figure 2. Profile pattern of PBDEs in sewage treated effluents at **a)**dissolved phase and **b)**particulate phase

According to the result, the concentration of PBDEs was higher in samples in particulate phase for both un-treated influents and the sewage treated effluents. The level of PBDEs in influent at dissolved phase and particulate phase ranged from 2.46 to 4.82ng/L and from 13.51 to 34.88ng/L, respectively. Majority of PBDEs present in sewage enters the treatment facilities through an adsorption to the particulate matters. The average Kd = Cp/Cs (where Cp, is the concentration on the particles and Cs, is the concentration in solution) of influents and the effluents of sewage treatment facilities was about 1,100L/Kg.

The profile pattern of PBDEs in influents showed the dominance of the 209-BDE. Overall, PBDEs contamination in sewage treatment influent was contributed in order of Deca-BDE>Nona-BDE>Penta-BDE>Tetra-BDE. Fig.1 and Fig.2 show the profile pattern of PBDEs in un-treated influents and the effluents that have been treated from the sewage treatment facilities. Based on the result, the amount of PBDEs released from the sewage treatment facilities to the environment has been estimated to be 224.71kg/year. Among them, the PBDEs release from the sewages and sledges to the environment was estimated as 33.74kg/year and 2009.97kg/year, respectively.

56.5% of the national PBDEs released from the sewage treatment facilities were from the capital area. Such result may be due to its high population density, which is associated with the greater use, and disposal of PBDE contained products. The PBDEs release through ocean dumping or from sewage treatment facilities to the water bodies is estimated as 140.8kg/year, being responsible for 62.6% of PBDEs discharged annually.

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