Distribution and Fate of Perfluorinated Compounds (PFCs) in the Sewage Treatment Plant

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Introduction

Perfluorinated compounds (PFCs), a class of emerging environmental pollutants due to its persistence, bio-accumulation, long range transportation and toxic effect, have been used for the last 50 years in industrial and commercial areas, such as coating, shampoos, electro plating, fire-fight, stain repellents for furniture and carpets. Widespread usage of these compounds has been attributed to their contamination in sewage[1]. For example, In New york state PFOA concentration of effluent in STP varies from 58~1,050 ng/L[1]. Jing et al. (2009) also reported that PFOA and PFOS were in the range of 11.1~1057.1 ng/L and 7.9~560.9 ng/L[2]. However their distribution and fate during the sewage treatment is not well reported. Therefore, in this study, we analyzed 10 PFCs in water samples and sludge collected from Sewage Treatment Plant in Korea and evaluated the levels, distribution and mass flow.

Material and Methods

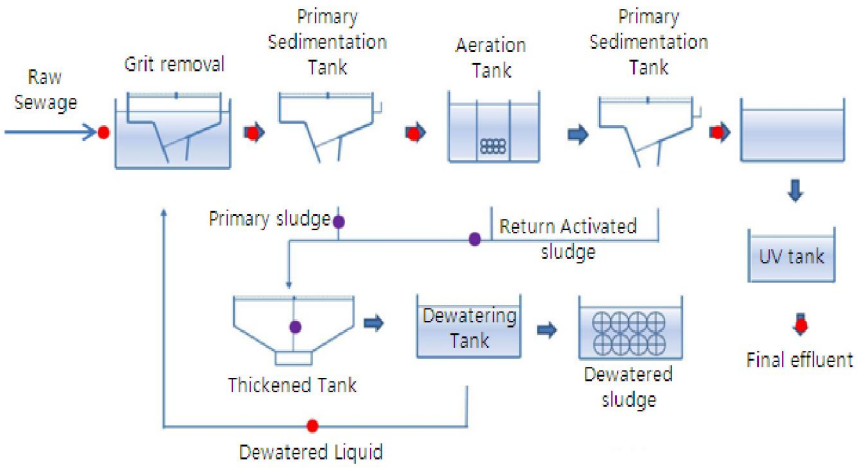

Fig. 1. Flow scheme of the sewage treatment plant for sampling

Water sample were filtered before extraction. Each sample was spiked ^{13}C-labeled PFOA and ^{13}C-labeled PFOS. All the water samples were extracted by solid phase extraction (SPE) cartridge (Oasis® HLB). The SPE cartridge was first preconditioned by passing through 5mL of Methanol and 5mL Milli-Q-water. The cartridges were not allowed to dry out during extraction process. After pre-conditioned, water samples were passed through cartridge at a rate of 1drop/s. And then the cartridges were washed with 3mL of 40%-Methanol in water, which was discarded. After drying of cartridge, the target analytes were eluted by 6mL-methanol. The eluent was concentrated and fixed 1mL. Sludge samples were dried before extraction and spiked ^{13}C-labeled PFOA and ^{13}C-

labeled PFOS. Sludge samples were extracted by adding 20mL-Methanol, treated using ultrasonic for 40min, then centrifuged for 30min. The supernatant was collected and concentrated to 1mL.The instrument analysis was carried out using a HPLC (Aliance 25695, Waters, USA) interfaced to an triple-quadrupole mass spectrometer (Quattro micro API, Micromass, USA). The used column was a reversed-phase C18 (Thermo Betasil®, 100×2.1mm, 5 ㎛ particle size) and column temperature was 35℃. Gradient conditions were used at 300 ㎕/min with 2mM-Ammonium acetate(A) and methaol(B) as mobile phase, starting at 10% B. Initial conditions were held for 0.1min and then 75% B for 7min, incresed 100% B till 10 min, held for 2min, decreased to 10% B for 20min.

Results and Discussion

The measured total PFCs concentration in water samples were in the range of 29.28~411.68 (average 80.46) ng/L. PFOA was the predominant compound in water sample (2.11~65.05, average 15.29 ng/L). Concentrations of PFOS were in the range of 0.42~24.92 (average 6.75) ng/L. Concentration of total PFCs was high during the winter season. The concentrations of PFOA determined in this study were lower than levels reported for STP water samples from New york state (58~1,050 ng/L)[1] and Singapore (11.1~1057.1 ng/L)[2]. In sludge samples, total PFCs was detected 1.22~7.20 (average 3.39) ng/L for 2 seasons. The values of PFOA and PFOS were in the rage of 0.21~1.50 ng/L and ND~2.20 ng/L respectively.

Mass flow were calculated by multiplying the concentration by the daily flow volume(Fig. 2). The concentrations of PFCs in effluent samples were higher than concentrations in raw influent samples. This is likely due to the existing of precursors[3].

In the compositions of relative concentrations of individual PFCs in water and sludge, PFOA was the dominant PFC in 10 of the 18 samples, whereas PFOS was predominant in sludge samples(Fig. 3).

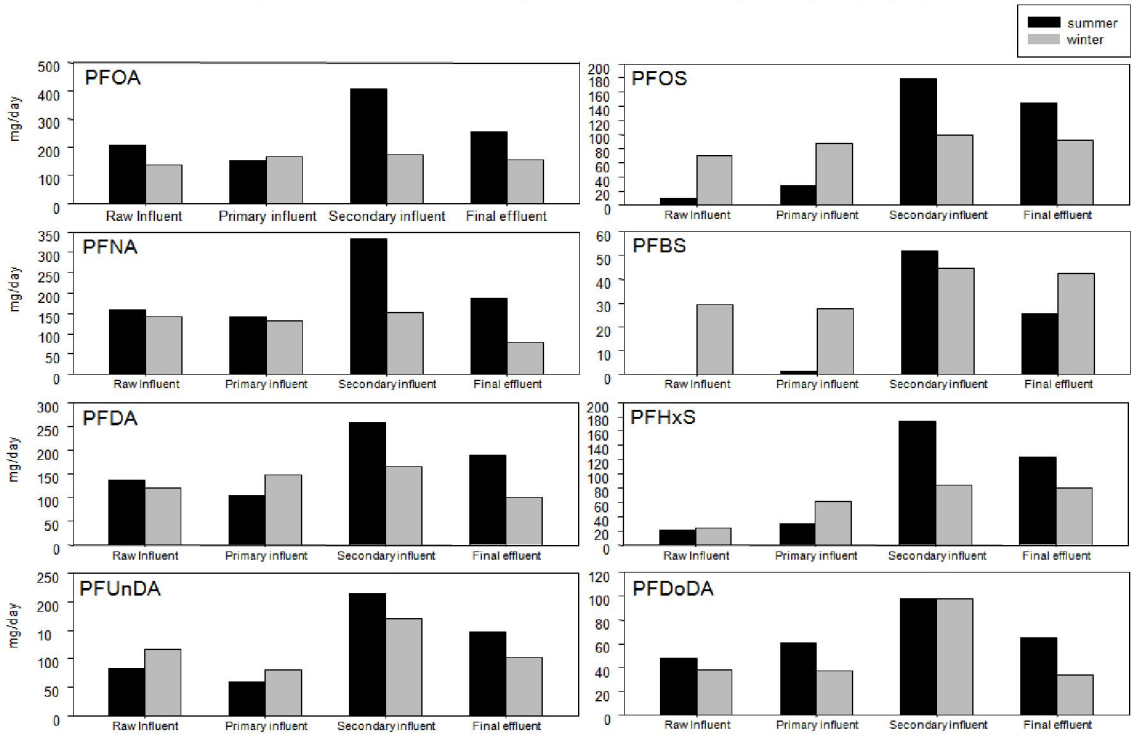

Fig. 2. Mass flow of PFCs in STP

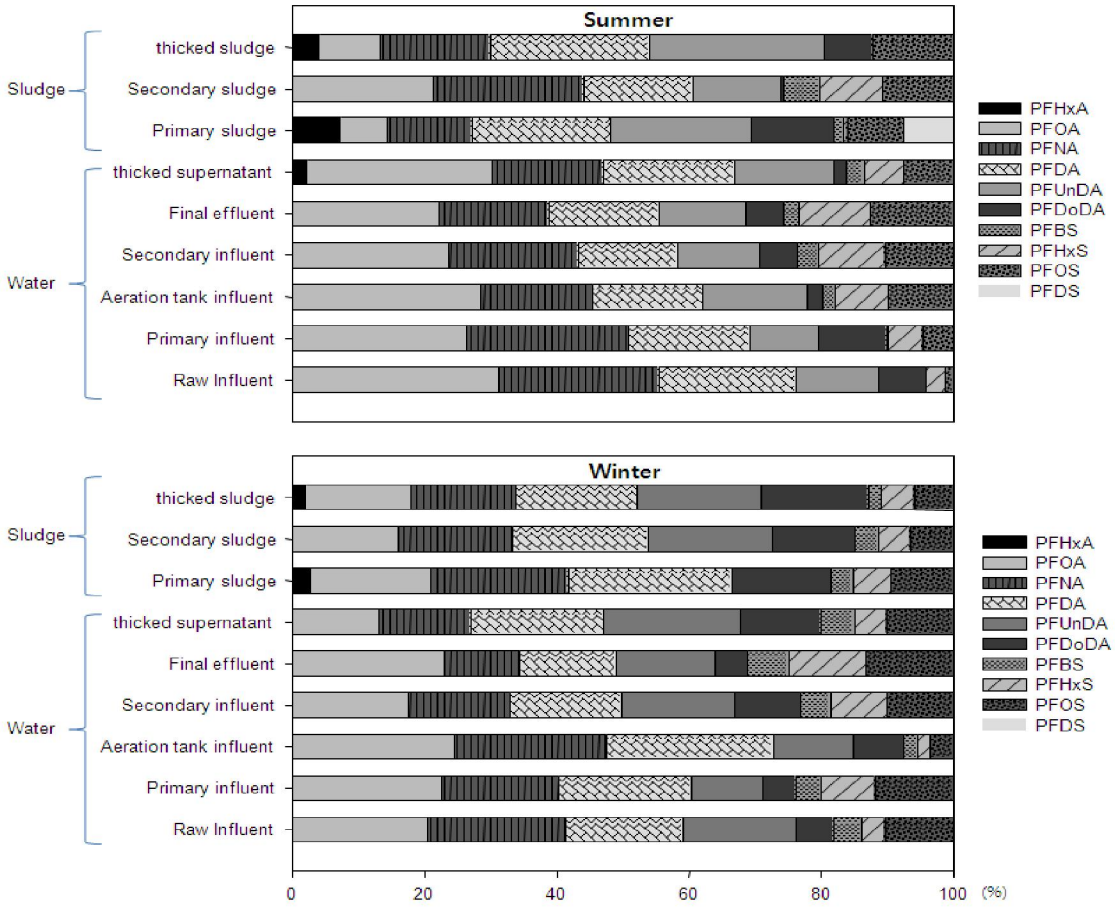

Fig. 3. Percentage contributions of PFCs in STP

Acknowledgements

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Reference

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