

THE DISTRIBUTION AND FATE OF POLYFLUORINATED COMPOUNDS IN WASTE WATER TREATMENT (WWTP) PLANT IN CHINA

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Introduction

Perfluorinated compounds (PFCs), a new kind of persistent organic pollutant, have caught worldwide attention. They are globally distributed in the environment, including air, surface water, groundwater, biota, sediment.^[1] Fluorochemicals were detected in wastewater treatment plant (WWTP) influents and final effluents. Discharge of effluents from wastewater treatment plants (WWTPs) is a source of these organic contaminants into the aquatic environments.^[2] In this study, influents and final effluents from twenty-eight wastewater treatment plants (WWTPs) from eleven cities in China were analyzed.

Materials and methods

Sample collection

Twenty-eight water samples (influent and final effluent) were collected from September to November, 2009 in wastewater treatment plants (WWTPs) from eleven cities in China (Figure 1). Water samples were collected and stored in 500 mL polypropylene (PP) bottles. All samples were stored at 4°C before extraction.

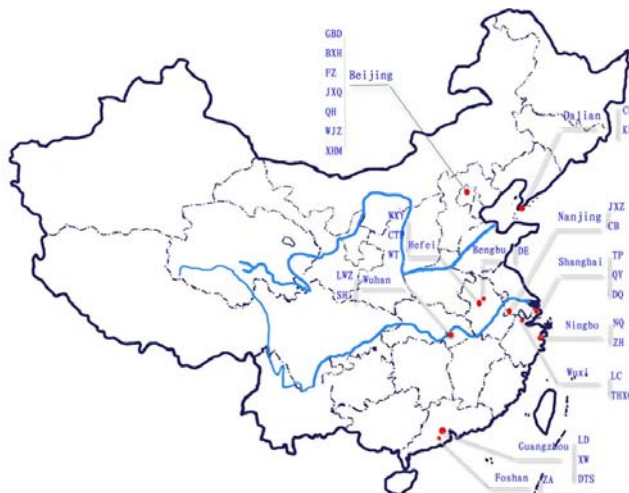


FIGURE 1 Sampling Location

Chemicals and reagents

The target analytes included perfluoroalkylsulfonates (C2-C4, C6, C8, C10), perfluorocarboxylates (C3-C18), perfluorooctanesulfonamide, N-ethyl perfluorooctane sulfonamide, and N-ethyl perfluorooctane sulfonamidoacetate. ¹³C labelled standards including ¹³C₂-PFBA, ¹³C₄-PFOA, ¹³C₅-PFNA, ¹³C₂-PFDA, and ¹³C₄-PFOS were spiked into the samples to check for overall recoveries of the analytical procedures. Unfiltered water samples were extracted using solid phase extraction (SPE) using WAX cartridges as described elsewhere^[3].

Instrumental analysis

Separation of the target analytes was performed using an Agilent HP1100 liquid chromatograph (Agilent, Palo Alto, CA) interfaced with a Micromass Quattro Ultima Pt mass spectrometer (Waters Corp., Milford, MA) operated in the electrospray negative ionization mode. A 10 µL aliquot of the extract was injected onto a Keystone Betasil C18 column (2.1 mm i.d. x 50 mm length, 5 µm, 100Å pore size, endcapped) with 2 mM ammonium acetate and

methanol as the mobile phase for the quantification of C6- C12 PFCs^[3].

Results and discussion

Eighteen PFCs were detected in wastewater sample, including C2-4, C6, C8 PFASs, C3-C12 PFCAs, and other (PFOSA, *N*-EtFOSA, *N*-EtFOSAA).

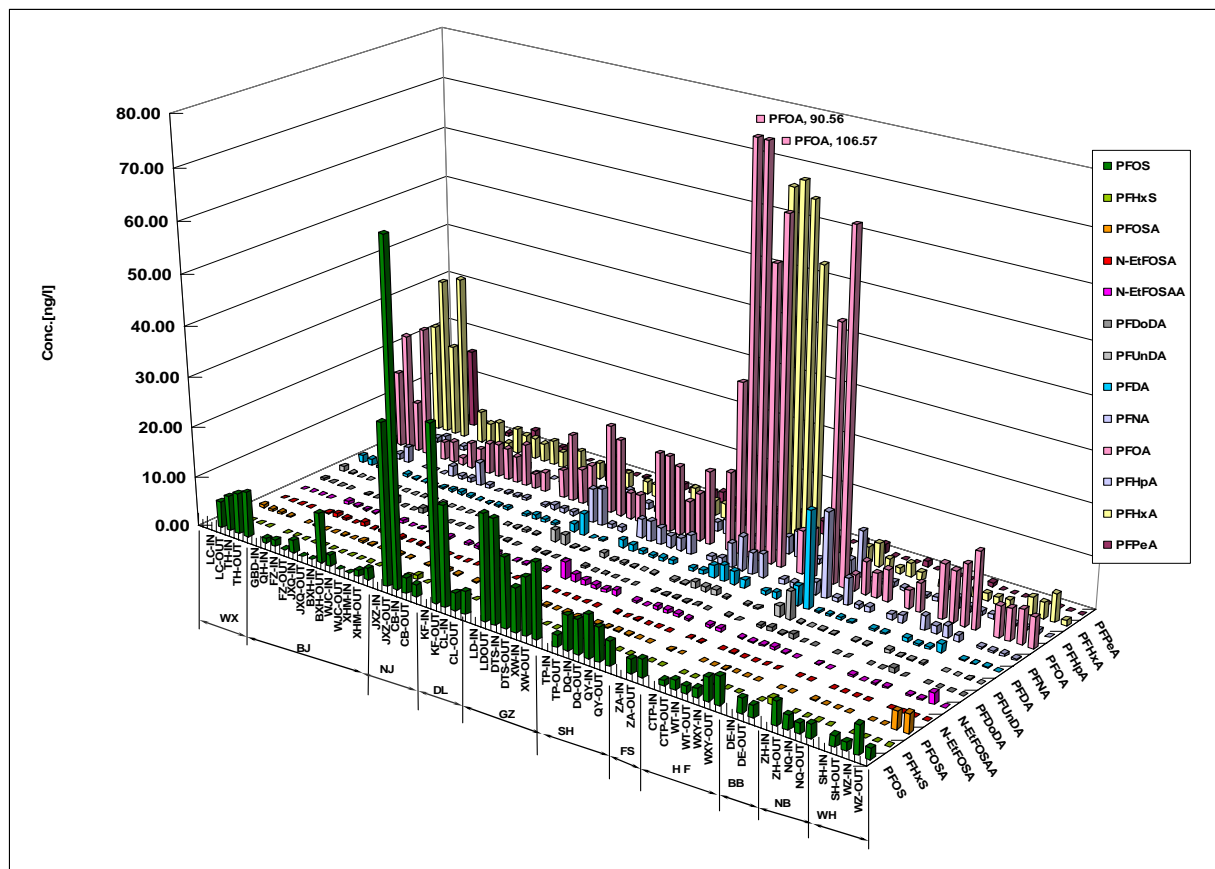


FIGURE 2 PFCs concentration in wastewater sample from each WWTP

PFCs concentrations of water samples from WWTPs in different Chinese cities

The concentrations and fate of PFCs in WWTPs in different cities varies. The most predominant PFCs in each city were also different. PFOA is predominant in the city of Shanghai, Hefei, Bengbu and Ningbo (36% in total 11 cities) while PFOS is predominant in the city of Nanjing, Guangzhou (18% in total 11 cities). The city of Wuxi has PFHxA as the predominant PFCs. The comparison of concentrations of predominant PFCs in each city would be interesting. The highest concentration of PFOA was found in Shanghai (106.67 ng/L). PFOS with the concentration of 67.32 ng/L was found in Nanjing, The concentration difference in locations may be due to the result of different kinds of treatment processes and sources of influents in each WWTPs and also different PFCs use according to kinds of industrial and commercial use in different cities.

Comparison of concentrations of PFOA in each WWTP

PFOA was found in every WWTP, both in influent water and effluent water, however, the concentrations varies. The decreasing rank of PFOA levels among effluents of different WWTPs are shown in figure 3. Among the first five highest concentrations WWTPs, all three from Shanghai were included. Shanghai is one of the biggest city in China, center of industry and commerce. The result of this study suggested that PFC-related chemical were widely used in this city.

The concentrations of total PFCs

The highest concentration of total PFCs (PFASs, PFCAs and others) was also found in effluent water in Dongqu WWTP in Shanghai (258.53 ng/L), followed by influent water in Kaifaqu WWTP in Dalian (178.63 ng/L) and effluent water in Caitianpu WWTP in Hefei (147.82 ng/L). The concentration of total PFCAs is higher than that of total PFASs in every WWTP, with the ratio, PFCAs/ PFASs, ranges from 1 to 17, and average in 4. PFOA, PFHxA and PFOS, are the major ones composed the total PFCs (Figure 4).

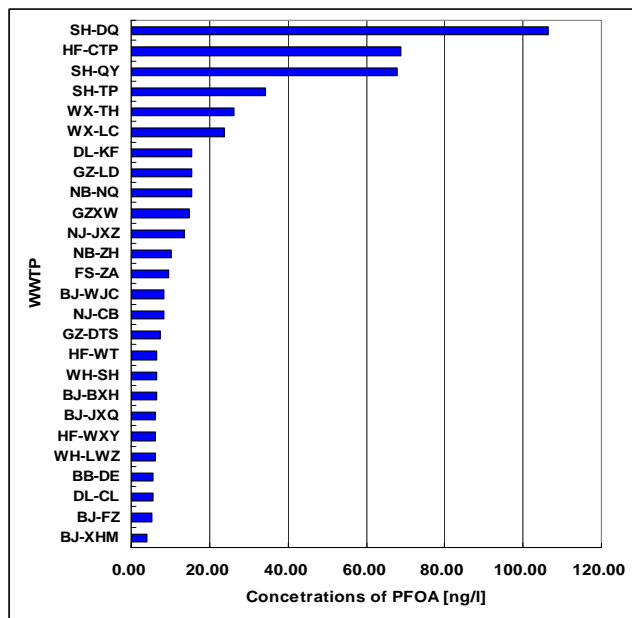


FIGURE 3 Concentrations of PFOA in effluents from each WWTPs

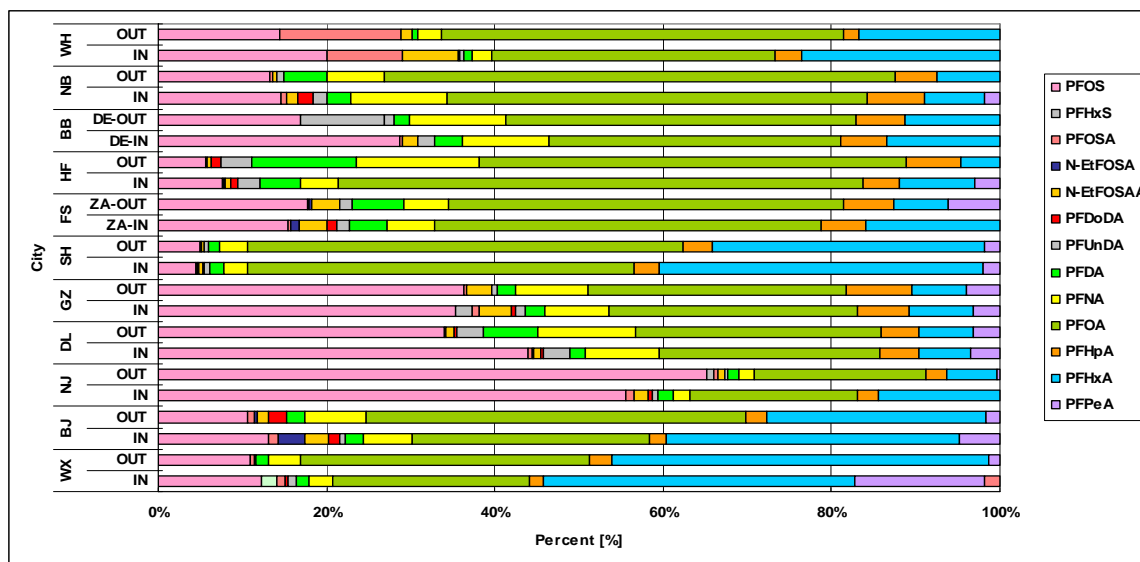


FIGURE 4 Composition profile of PFCs in wastewater samples from each WWTP

Comparison of concentrations from effluents and influents of WWTPs

For PFOA, among 26 WWTPs, the concentrations of PFCs from final effluents were higher than the concentration of influents in 21 WWTPs, with a percentage of 81%. Some study presume the increase may due to the degradation of its precursor^[4]. Another PFC, PFNA, also has this tendency of concentration increase during the process of WWTP, with a percentage of 81%. This higher concentrations in effluents suggest that WWTP process can not remove the PFCs efficiently.

The correlations analysis of PFCs

The correlations among PFCs in all samples were analyzed using a Spearman rank correlation analysis. Significant correlations were observed among PFOS and other compounds (PFOSA,, and PFOA). PFNA did not correlate well with PFOS as well as PFDA and PFUnDA in this study.

Acknowledgements

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