

Total Perfluoroalkyl Acid Precursors in Sewage Treatment Plant Effluents

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Introduction

Perfluorooctane sulfonate (PFOS) has been classified as a persistent organic pollutant (POP) and perfluorooctanoic acid (PFOA) has been under self-regulation by manufacturers. However, there has been no regulation on their precursors which will eventually decompose into perfluoroalkyl acids (PFAAs) such as PFOS and PFOA. As potential sources of PFAAs, there are numerous PFAA precursors but their occurrence has not been well characterized. The monitoring of PFAA precursors is difficult because there are no analysis methods for many of the precursors. To understand the levels and emission sources of those unidentified PFAA precursors in aquatic environment, information on their occurrence in wastewater including sewage treatment plant effluent is urgently needed.

Methodology

We investigated the sewage treatment plants that discharge their effluent into the Tama River, whose river water is composed of sewage treatment plant effluent by approximately 50%. Effluent samples were collected from the outlet of the sewage treatment plants. To be analyzed by the routine method, all the PFAA precursors were transformed into perfluorinated carboxylic acids (PFCAs) of the corresponding perfluorinated chain length by the oxidation method introduced by Houtz and Sedlak (2012). PFCAs in the samples were analyzed both before and after oxidation. By comparing the concentrations before and after oxidation, the total concentrations of PFAA precursors could be inferred.

Results and Discussion

The oxidation treatment of the samples produced significant amounts of PFCAs. Compared to the river water samples (5.7 ng/L in average), higher concentrations of PFAA precursors (12 ng/L in average) were observed in the sewage treatment plant effluents. These indicated that the sewage treatment plant effluent was one of the large sources of PFAA precursors into the environment. However, the proportions of precursors (inferred from differences between pre- and post-oxidation) against total PFAAs determined by pre-oxidation in sewage treatment plant effluents (19% in average) were lower than those in the river waters (36% in average). This indicated that decomposition of some precursors might have occurred in the sewage treatment process. Our results supported the hypothesis that some precursors decompose in sewage treatment plant and result in the elevated levels of PFAAs including PFOS and PFOA in the effluents that flow into the aquatic environment.

Conclusion

The sewage treatment plant effluents were indicated as one of the large sources of PFAA precursors into the environment. Our study also showed that PFAA precursors that cannot be monitored by the routine analysis methods existed in effluents at a level of 20% of total PFAAs determined by the routine method. This means that total PFAA concentration from effluents into aquatic environment will increase by about 20% eventually through the decomposition of the precursors.

Key words: precursor, perfluoroalkyl, sewage, PFOS, degradation