# Study on the Behavior of Perfluorinated Carboxylic Acids during Biological Treatment Process in Wastewater Treatment Plant

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Key Word : *Perfluorinated carboxylic acids(PFCAs), micro pollutants, water pollution, wastewater treatment plant, analytical method*

## 1. BACKGROUND AND OBJECTIVES

Perfluorinated carboxylic acids (PFCAs) have been widely used such as in the production of Teflon. Previous studies have indicated that wastewater treatment plants (WWTPs) are one of the sources of PFCAs to public water body. However, there is little knowledge on the behavior of PFCAs with different carbon chain lengths at WWTPs. Objectives of this study are to understand the occurrences of nine PFCAs at WWTPs, to examine analytical method of particulate (PS) phase PFCAs in WWTP samples, and to understand the behavior of PFCAs during biological treatment process.

## 2. METHOD OF SURVEYS AND EXPERIMENTS

**(1) Occurrences of PFCAs at WWTP:** A survey was conducted to analyze dissolved (DS) and PS phase PFCAs at each treatment process of a WWTP in Japan.

**(2) Analytical methods for PS phase PFCAs in WWTP samples:** Three extraction methods and three pretreatment methods were tested to suggest a simple and effective analytical method for PS phase PFCAs in WWTP samples. .

**(3) The behavior of PFCAs during biological treatment process:** Batch adsorption experiment onto sludge was carried out under aerobic condition.

**Analytical Procedures:** Samples were analyzed by using SPE-LC-MS/MS technique and new pre-treatment steps were applied where appropriate.

## 3. RESULTS AND DISCUSSIONS

Summary of the results is shown in **Figure 1**.

In the first objective, two PFCAs were not detected for all samples. The total mass flow of 7 PFCAs in effluent was 2.6 times higher than that of influent. All the surveyed PFCAs were found at their highest concentration during biological treatment process. In aeration tank, the mass flow of PFOA and PFNA were increased 4.5 times and 4.6 times, respectively. In addition, 41% of the PFOA mass from aeration tank were distributed to return sludge and recirculated (In case of PFNA, 70%).

In the second objective, Methanol-shaking followed by Envi-Carb treatment provided the best recovery (71-110%) and relative standard deviation (less than 20%) for analyzing 7 PFCAs. The developed method was simple and time-saving as well as showing high accuracy and precision.

In the third objective, adsorption behavior of PFHxA, PFOA and PFNA were analyzed by *Freundlich* absorption isotherm equation. The adsorption capacity shown by $K_F$ was PFNA ( 1.36 ) > PFOA (0.07) > PFHxA (0.06) and it indicated that longer chain PFCAs are more adsorbed by activated sludge than shorter chain PFCAs. Furthermore, there is a possibility that inactivated sludge has higher capacity to adsorb PFCAs than activated sludge.

## 4. CONCLUSION

As a result of this study, different adsorption behavior of each PFCA during biological treatment process is suspected to influence the mass loading of PFCAs at WWTPs. In addition, the developed analytical method can provide a time-saving PFCAs analysis for the researchers who deal with experiments using activated sludge.

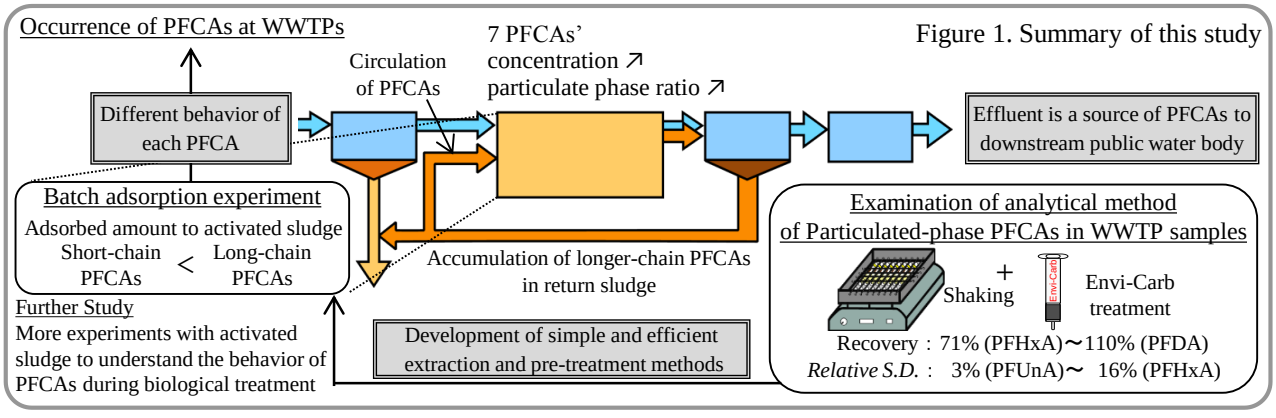


Figure 1. Summary of this study