Occurrence of Per- and Polyfluoroalkyl Substances in Water Environment in Okinawa and Application of Ion Exchange Resins in Drinking Water Treatment Processes

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1. Background and Objectives

Per- and Polyfluoroalkyl Substances (PFASs) are artificial organofluorine compounds which have been reported to be persistent and reproductive toxicity. PFASs have been used in aqueous film-forming foam. Perfluoroalkyl acids (PFAAs) Precursors make problem complicated. In 2016, U.S. Environmental Protection Agency (U.S. EPA) announced Drinking Water Health Advisory, perfluorooctane sulfonic acid (PFOS) and perfluorooctanoic acid (PFOA), totaling 70 ng/L[1]. The water source river of the drinking water treatment plant (DWTP) in Okinawa is located downstream of the air force facilities. The main objectives of this study are to investigate the occurrence of PFASs in water treatment processes and their water sources of Okinawa, and to examine the treatment with ion exchange resins compared to granular activated carbon.

2. Materials and Methods

The field surveys on pollution were conducted in the water environment such as rivers, tap water, water source and water treatment processes in the DWTP of Okinawa from Oct. 2018 to Oct. 2019. 15PFAAs, 10precursors, Total Oxidizable Precursors (TOP) and total organic fluorine of these samples were analyzed by LC-MS/MS (Agilent). Furthermore, desorption experiments of activated carbons which were used in a DWTP and adsorption test with ion exchange resins.

3. Results and Discussion

The concentrations of PFOS, PFOA and their oxidizable precursors in processes water of the DWTP has shown in **Fig. 1**. Treated water of the total concentration of PFOS and PFOA was 28 ng/L and their oxidizable precursors were 55 ng/L, in the result, the total concentration exceeded 70 ng/L. PFOS was detected at 196 ng/L from the upstream of the source river. It was suspected that the inflow from the river to the DWTP.

The behavior of the total loading of PFOS, PFOA and there oxidizable precursors in the DWTP has shown in **Fig. 2**. The contribution of PFASs from river water and dam water was larger than well water, and it was reduced to 24% by coagulation sedimentation treatment and BAC treatment. The contents of PFOS, perfluorohexane sulfonic acid (PFHxS) and fluorohexanesulfonamide (FHxSA) which were eluted from activated carbon with different use periods has shown in **Fig. 3**. PFOS content continued to increase as the period of use became longer, while the content of PFHxS became steady after 14 months of use. Furthermore, it was suggested that FHxSA was changed to PFHxS on the BAC tank. For 15PFAAs, the ion exchange resin (A592E) treatment efficiency was 2.0 times higher than GAC.

4. Conclusion

In Okinawa, PFAAs and their precursors flowed from the water source river into the DWTP, and suggesting that PFAAs were formed on BAC. Furthermore, suggesting the usefulness of ion exchange polymer for PFAAs.

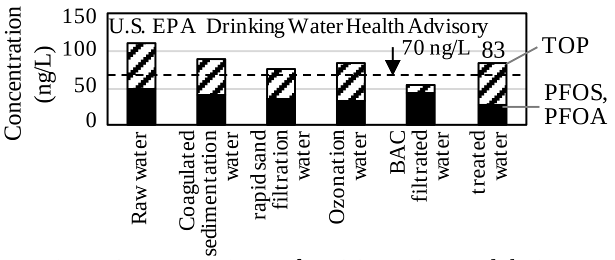

Fig. 1 Concentrations of PFOS, PFOA and their oxidizable precursors in processes water of the DWTP

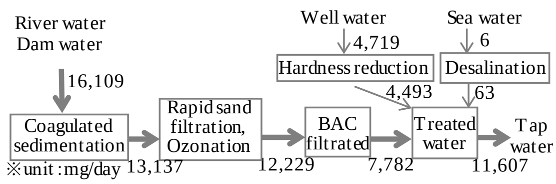

Fig. 2 Total loading behavior of PFOS, PFOA and their oxidizable precursor

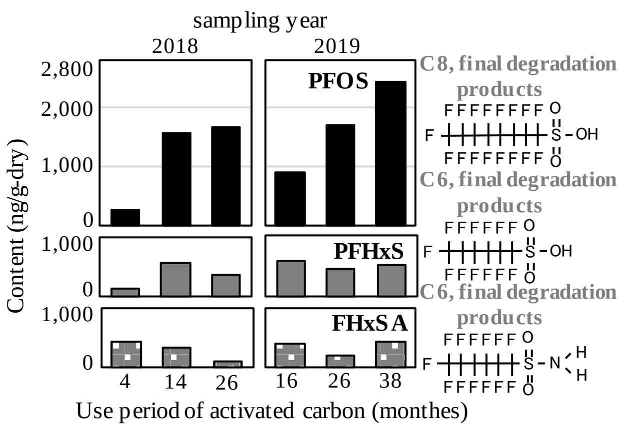

Fig. 3 Content of PFOS, PFHxS and FHxSA eluted from activated carbon with different usage periods

Reference: 1）EPA. US., 2016: https://www.epa.gov/ground-water-and-drinking-water/drinking-water-health-advisories-pfoa-and-pfos,