PFAS in water and sludge from wastewater treatment plants in Bergen, Norway



Are Sæle Bruvold¹ , Nachiket Marathe¹, Didrik Grevskott¹, Nawaf Al Shehri² , Stig Valdersnes^{1,3} , Aasim M. Ali¹ 1 Institute of Marine Research, P.O. Box 1870 Nordnes, NO-5817 Bergen, Norway 2 Department of Marine Chemistry, King Abdulaziz University, Jeddah, Saudi Arabia 3 University of Bergen, Department of Chemistry, PO Box 7803, N-5020 Bergen, Norway aresb@hi.no

PFAS in wastewater treatment plants (WWTPs)

Industry, consumer products and aqueous film forming foam contaminated sites such as Flesland airport are major sources for PFAS, much of which enter WWTPs. Unfortunately, wastewater treatment is inefficient at removing PFAS due to their exceptional persistence. Transformation of PFAS and PFAS precursors occur in the environment and during wastewater treatment, complicating their determination. Available data on WTTPs especially in Norway is limited and focus on a handful of the most prominent PFAS, despite the existence of millions of PFAS.

AIM

The work aims to determine the burden and understand the fate of a wide range of PFAS in WWTPs to facilitate risk assessment and mitigation strategies.

SAMPLING





EXPERIMENTAL ASPEC Wastewate Target analysis by QqQ QuEChERS ewage sludge NTS by HR-Mទ័

RESULTS AND DISCUSSION

WASTEWATER



Fig. 1 Mean concentrations over all wastewater samples. Flesland associated with overal elevated concentrations and PFNA





or negative removal (= transformation) of PFAS.

Thousands of ng/L PFAS are detected in wastewater, the hotspot Flesland associated with the highest levels. Removal efficiences of measured PFAS are low, effluent levels comparable or greater than the influent due to transformations. This is true especially for short chain PFAS. Levels are high in comparison to those reported internationally. This results in the pollution in the order of tens of kg PFAS per year per treatment plant to the marine environment.

CONCLUSIONS

- WWTPs represent a substantial source of various PFAS to the marine environment.
- Current treatments rather transform than remove PFAS.
- Long chain PFAS accumulate in the sludge Investigation into the environmental fate of PFAS as well as alternative
- treatment and disposal strategies is warranted.

SEWAGE SLUDGE



Fig. 4 PFAS Concentrations in sludge for each location





Fig. 5 Distribution coefficients between sludge and water for PFAS above LOQ for all sludge samples

Fig. 6 Ongoing suspect and non-target screening of PFAS using mass defect, mass error, PFAS fragment library match scoring and mass to carbon ratio.

Sewage sludge retains primarily long chain PFAS, whereas short chain distribute in the water phase. Levels are comparable to previous reported levels. High levels are especially found in samples from Flesland, using a biological process (activated sludge) with longer residence time and thus more potential for transformation products to be identified using NTS. The sewage sludge is used as fertilizer in parks and for cereal production. motivating future investigation into the uptake of PFAS into plants and livestock.

Part of the project Fate and Effects of Perfluoroalkyl Substances (PFAS), Their Precursors, and Alternatives in Norwegian Marine Environments and Seafood Species (FEARLESS) funded by The Research Council of Norway.



Get in touch: Are Sæle Bruvold Institute of Marine Research aresb@hi.no arebruvold.com/research.html