PER- AND POLYFLUOROALKYL SUBSTANCES (PFAS) REMOVAL IN DRINKING WATER WITH POINT-OF-USE WATER TREATMENT SYSTEMS

by

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ABSTRACT

Since the 1940s, per- and poly-fluoroalkyl substances (PFAS) have been present in our environment, but only recently have they gained much attention and are now considered emerging contaminants in water, which on exposure to humans, can lead to serious health issues. PFAS comprises complex human-made chemicals used to manufacture various consumer-based products such as firefighting foam, non-stick utensils, water-repellent clothes, stain-resistant materials, and food packaging products. A characteristic, that distinguishes PFAS from all other compounds is their strong carbon-fluorine bonds, which is also the reason for their high chemical and thermal stability. Moreover, PFAS are highly mobile and non-degradable in the environment; therefore, many can stay absorbed in human and animal bodies for a significant amount of time. Drinking water acts as a significant source of PFAS exposure to humans in communities where these chemicals have contaminated the water supply source. Even a minimal amount of PFAS in drinking water can lead to high levels of PFAS in the human body. Studies on animals prove that continuous exposure to PFAS can lead to adverse health effects such as liver, kidney, and reproductive issues. Point-of-use (POU) water treatment systems are considered beneficial in getting rid of trace-level contaminants that remain in the treated drinking water. Membrane filtration systems and activated carbon systems are two highly efficient POU systems, but their potentials to remove emerging contaminants such as per- and polyfluoroalkyl substances (PFAS) have not been fully explored. Therefore, there is a critical need to evaluate their removal efficiency and the factors that impact PFAS removal. For this study, six POU drinking water treatment systems were selected, out of which three used reverse osmosis (RO), and the rest used granular

activated carbon (GAC) media as their removal technique. Two different sets of influent concentrations were tested to evaluate performances of these POU systems: low concentration/dosage (1ug/l) and medium concentration/dosage (10ug/l). The removal efficiency was determined using solid phase extraction to concentrate and purify the samples followed by tandem liquid chromatography mass spectrometry (LC/MS/MS). The results showed that with an increase in influent dosage, the removal efficiency improved in both RO and GAC-based point-of-use filters.

Furthermore, PFAS can be classified as either long-chained (carbon chain length >=7) or short-chained (carbon chain length <7) chemicals. Short-chained PFAS chemicals came as a replacement to long-chained PFAS as it was considered that due to their shorter chain length, they would be easier to degrade than long-chain PFAS. However, different studies provided different conclusions on the toxicity and the removal of short-chained PFAS chemicals. Hence, there is still a knowledge gap on the removal and effects of short-chained PFAS in drinking water. Thus, to evaluate the effect of chain-length on removal efficiency of PFAS in POU systems, I studied three PFAS chemicals with different chain-lengths, one long-chained PFAS compound: PFOS (perfluorooctane-sulfonate), and two short-chained PFAS chemicals: PFHxS (perfluorohexane-1-sulphonic acid) and PFBS (perfluorobutane-sulfonate). The results indicated that the short-chained PFAS compounds had a lower removal efficiency rate than the long-chained PFAS chemicals. Overall, this research's outcomes are expected to improve the efficiency of POU water treatment devices significantly.