DEGRADATION OF PERFLUOROALKYL SUBSTANCES IN ULTRAPURE AND GROUNDWATER THROUGH NON-THERMAL PLASMA

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Perfluoroalkyl Substances (PFAS) represent one of the most recalcitrant class of compounds of emerging concern and their removal from water is a challenging goal [1]. In this study, we investigated the removal efficiency of three PFAS from water, namely, perfluorooctanoic acid (PFOA), perfluorohexanoic acid (PFHxA) and pefluorooctanesulfonic acid (PFOS) using a custom-built non-thermal plasma generator.

The effect of plasma discharge frequency, distance between the electrodes and water conductivity on treatment efficiency was investigated. Then, the plasma treatment was used to degrade the PFAS at the μgL^{-1} level both individually and in mixture, in ultrapure and groundwater matrices.

PFOS at 1 μgL^{-1} exhibited the best degradation reaching complete removal after 30 min in both water matrices (first order rate constant 0.107 min^{-1} in ultrapure water and 0.0633 min^{-1} in groundwater), while the degradation rate of PFOA and PFHxA was slower of around 65% and 83%, respectively. During plasma treatment, the production of reactive species in the liquid phase (hydroxyl radical and hydrogen peroxide) and in the gas phase (ozone, NO_x) was investigated. Particular attention was dedicated to the nitrogen balance in solution where, following to NO_x hydrolysis, total nitrogen (TN) was accumulated at the rate of up to 40 $mg^N\ L^{-1}\ h^{-1}$.

The promising degradation results obtained for the tested compounds and in particular for PFAS, suggest that this technology could be efficiently used for the treatment of contaminated groundwater, especially when water conductivity is low. Being the PFAS probably the most recalcitrant compounds among the contaminants of emerging concern [2], the obtained promising results with these substances makes us confident that the plasma technology is also able to degrade less inert compounds.

References

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