

COMPLETE DESTRUCTION OF PFAS USING ULTRAVIOLET-LIGHT ACTIVATED OXIDATIVE AND REDUCTIVE PROCESSES

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Background/Objectives:

Per- and polyfluorinated alkyl substances (PFAS) are persistent environmental contaminants linked to potential toxicity and risks to human and ecological health. Their widespread use, particularly in aqueous film-forming foams (AFFFs) for firefighting, has resulted in significant contamination of groundwater and drinking water supplies. The durability of PFAS compounds, combined with their mobility in soil and water, presents substantial remediation challenges.

This study aims to develop robust, portable treatment technology capable of achieving complete PFAS destruction in aqueous, and solid matrices, offering a practical solution for mitigating liability and meeting regulatory requirements.

Approach/Activities:

This work evaluates the use of ultraviolet (UV) light activated sulfite and iodide (UV/S+I) as a novel PFAS remediation method. UV light technologies, widely used in water treatment, generate aqueous electrons that target strong carbon-fluorine bonds in PFAS, enabling destruction without the need for high temperatures, pressure, or salts.

The system's efficacy was tested on a range of PFAS compounds, including PFOS, PFOA, 6:2 FTS, PFBA, PFBS, TFA, and PFAS prevalent in AFFFs. It was also evaluated under challenging conditions, such as the presence of butyl carbitol, alcohols, nitrates, carbonate, high salinity, dissolved metals, sulfate, organic matter, surfactants, ammonia, and phosphate. Key inhibitors, such as nitrates and turbidity, were addressed through process modifications, including increased sulfite dosing and pre-oxidation with persulfate. UV-activated oxidation processes (e.g., hydrogen peroxide, persulfate) were applied before and after UV/S+I treatment to manage interfering components and residual transformation products. A portable, scalable flow-through reactor was developed to integrate this technology into existing wastewater treatment systems.

Results/Lessons Learned:

The UV/S+I system achieved >99% PFAS destruction and near-complete inorganic fluoride recovery (90-110%) for a suite of C4 to C14 PFCAs, C4 to C12 PFSA's and several fluorotelomers. The system demonstrated the capability to treat PFAS concentrations greater than 500 mg/L and performed effectively in the presence of various interfering substances. PFAS destruction efficacy was maintained in the presence of several co-contaminants and common water constituents (e.g., salts, organic matter). It was identified that aqueous electron scavengers, like nitrate, and solution turbidity significantly impacted PFAS destruction at higher concentrations. Several strategies were investigated to improve system robustness in the presence of these water components, including filtration, oxidative pre-treatment, and increasing the concentration of photosensitizers.

When chemical and engineering parameters were optimized, the system consistently exceeded 99% PFAS destruction, as confirmed by LC-MS/MS and inorganic fluoride analysis. This portable flow-through reactor represents a scalable and practical solution for PFAS remediation.

About The Author

Natalia O'Connor is a research and development scientist with Parsons focused on the remediation of emerging contaminants, including PFAS.

