The Destruction of Per and Polyfluoroalkyl Substances Using a Portable, Scalable Ultraviolet Light Flow-Through Reactor

Per- and polyfluorinated alkyl substances (PFAS) have become a critical concern for federal sites due to their extensive use in manufacturing processes that impart hydrophobicity, lipophobicity, and chemical and thermal resistance. These properties have led to PFAS contamination in various environments, posing significant risks to human health and ecological systems. The persistence and potential toxicity of PFAS have prompted stringent regulations, including the ban of manufacturing, use and sale of specific compounds such as perfluorooctane sulfonate (PFOS) and long-chain perfluoro carboxylic acids (PFCAs) in Canada. Federal sites face increasing liability and regulatory pressure to address PFAS contamination, necessitating effective remediation technologies that can rapidly and efficiently destroy PFAS in complex matrices. The establishment of a drinking water objective for the sum of 25 PFAS compounds underscores the urgency for innovative solutions to protect public health and comply with regulatory standards.

This study investigates the application of ultra-violet (UV) light activated sulfite and iodide as a novel approach to PFAS remediation. UV light technologies, commonly employed in water treatment, offer a promising method for PFAS destruction without the need for high temperatures, pressure, or salts. By generating aqueous electrons, this technique targets the robust carbon-fluorine (CF) bonds characteristic of PFAS, overcoming the high energy barriers typically associated with PFAS destruction.

Our research evaluates the efficacy of this method on a range of PFAS compounds, including PFOS, PFOA, 6:2 FTS, PFBA, PFBS, TFA, and PFAS prevalent in aqueous film-forming foams (AFFFs). The system demonstrates the capability to handle high PFAS concentrations (>500 mg/L) and has been tested in the presence of various substances such as butyl carbitol, alcohols, nitrates, carbonate, salinity, dissolved metals, sulfate, organic matter, surfactants, ammonia, and phosphate. Key inhibitors of PFAS destruction include nitrates and turbidity, which obstruct UV light. To address these challenges, methods such as increased sulfite dosing and pre-oxidation with persulfate have been explored.

Significant engineering advancements have led to the development of a novel, portable, and scalable flow-through reactor, designed for integration into existing wastewater treatment systems at federal sites. When chemical and engineering parameters are optimized, PFAS destruction exceeds 99%, as confirmed by LC-MS/MS and inorganic fluoride analysis. This study highlights the potential of UV-activated sulfite and iodide systems as a viable solution for PFAS remediation, offering federal sites a pathway to mitigate liability, comply with regulations, and protect environmental and public health in complex aqueous environments.

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Natalia O’Connor, M.Sc., is a Project Scientist at Parsons in Syracuse, New York, with a strong interdisciplinary background in biology, biotechnology, engineering, and chemistry. Her expertise centers on the investigation and remediation of emerging contaminants, including per- and polyfluoroalkyl substances (PFAS) and chemical warfare agents, with a developing focus on nanomaterials and microplastics. She specializes in the application of innovative UV-activated reduction processes for the destruction of PFAS in aqueous matrices and leverages her understanding of chemical and biological processes to develop sustainable contaminant mitigation strategies.

Ms. O’Connor holds a Master’s degree in Chemistry and Chemical Engineering from the Royal Military College of Canada, an Advanced Diploma in Biotechnology from St. Lawrence College, and a Bachelor of Science in Biology and Neuroscience from Carleton University.

During her graduate studies, Natalia also served as a Technical Lead with the Environmental Sciences Group at the Royal Military College of Canada, where she led projects aimed at destroying PFAS-impacted rinsate and investigation-derived materials related to decontamination of PFAS-impacted mobile fire suppression systems.

In her current role at Parsons, Ms. O’Connor supports several internal research and development projects focused on UV-activated PFAS remediation, analysis, and characterization. “