Merits and Limitations of Various Advanced Oxidation Processes for PFAS Degradation

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Abstract

Per- and polyfluoroalkyl substances (PFAS) are an expansive class of over15,000 highly persistent, synthetic toxic chemicals that are polluting water and soil all over the world. In the US, the U.S. Environmental Protection Agency (USEPA) just promulgated unprecedentedly stringent drinking water maximum contaminant limits (MCL) that reflect their perceived toxicity and bioaccumulation potential. Specifically, the USEPA set drinking water standards for six compounds: perfluorooctanoic acid (PFOA) and perfluorooctane sulfonic acid (PFOS) at 4 ng/L, perfluorohexanesulfonic acid (PFHxS), perfluorononanoic acid (PFNA), and Hexafluoropropylene oxide dimer acid (HFPO-DA, GenX) at 10 ng/L, and a Hazard Index of 1 for mixtures containing two or more of PFHxS, PFNA, GenX, and perfluorobutane sulfonate (PFBS). Currently, China's Standards for Drinking Water Quality (GB5749-2022) allow 80 ng/L of PFOA and 40 ng/L of PFOS3. Furthermore, the EU plans to regulate total organofluorine (TOF) as a whole. Meeting these standards will require the development of new cost-effective treatment technologies for many different types of PFAS with a wide range of chemical compositions and unique and poorly understood interfacial properties. In this talk, we will review the mechanisms associated with PFAS degradation by various advanced oxidation processes, including photocatalytic, electrocatalytic, photo-Fenton treatment, discern the importance of various reactive species, and discern their merits and limitations.

Short Bio

Pedro J.J. Alvarez is the George R. Brown Professor of Civil and Environmental Engineering at Rice University, where he also serves as founding Director of the NSF ERC on Nanotechnology-Enabled Water Treatment (NEWT) and Director of the Rice Water Institute. His research interests include environmental implications and applications of nanotechnology, bioremediation, fate and transport of toxic chemicals, water footprint of biofuels, water treatment and reuse, and antibiotic resistance control. Pedro received the B. Eng. Degree in Civil Engineering from McGill University and MS and Ph.D. degrees in Environmental Engineering from the University of Michigan. He is the 2012 Clarke Prize laureate and also won the 2014 AAEES Grand Prize for Excellence in Environmental Engineering and Science. Past honors include President of AEESP, the Perry McCarty AEESP Founders' Award for Outstanding Contributions to Environmental Engineering Education & Practice, the AEESP Frontiers in Research Award, the WEF McKee Medal for Groundwater Protection, the SERDP cleanup project of the year award, the Brown and Caldwell lifetime achievement award for site remediation, the ASCE Freese Award, the Outstanding Achievement Award from the Chinese Chemical Society, and various best paper awards with his students. Pedro has served on the advisory committee of the NSF Engineering Directorate and on the scientific advisory board of the EPA, and is currently an Executive Editor of Environmental Science and Technology. He was elected to the National Academy of Engineering and to the American Academy of Arts and Sciences for pedagogical and practical contributions to bioremediation and environmental nanotechnology. Alvarez is also an international member of the Chinese Academy of Engineering.