Goldschmidt 2026 Abstract
https://doi.org/10.46427/gold2026.35453

Sulfidated zerovalent iron as a reactive nanomaterial for anaerobic degradation and defluorination of the perfluorinated antidepressant compound fluoxetine

SIYUAN MU, LAN LIU, STEPHANE BAYEN AND SUBHASIS GHOSHAL

McGill University

Sulfidated nanoscale zerovalent iron (S-nZVI) is a promising candidate for the dehalogenation of many emerging contaminants in the aquatic system and has recently been shown to enable effective dechlorination to chlorinated or brominated aliphatic and aromatic pollutants. However, effective defluorination by S-nZVI has only been shown in compounds where other halogen atoms are present (e.g., Cl- and F-containing florfenicol). Fluoxetine (FLX) is a widely detected pharmaceutical in the environment and is discharged into the environment primarily through wastewater treatment plant effluents and waste sludge. FLX is of concern because of its toxicity to aquatic biota at levels as low as a few ppt. It is also a poly- and perfluorinated alky substance (PFAS) according to the OECD. Current strategies for FLX degradation often yield incomplete defluorination with formation of persistent byproducts (e.g., trifluoroacetate) or rely on costly catalysts that hinder field-scale implementation. Here, we demonstrate the capacity of S-nZVI for complete defluorination of FLX and its perfluorinated moiety, even though no other halogen atoms are contained in the molecule. Anaerobic degradation and defluorination of FLX by S-nZVI was tested across five sulfidation levels ([S/Fe] = 0.01 - 0.38) in microcosms at 25 °C and 38 °C. Under electron-excess conditions at 38 °C, tuning the sulfidation extent of S-nZVI achieved complete degradation of 8 mg/L FLX with up to 87% defluorination. Product analysis indicates rapid side-chain cleavage to phenylpropan-1-1amine ($C_{10}H_{15}N$) and 4-(trifluoromethyl) phenol ($C_7H_5F_3O$), followed by sustained defluorination of fluorinated intermediates to nonfluorinated products including 4-hydroxybenzoic acid ($C_7H_6O_3$), TP-257 ($C_{14}H_{10}O_5$), and 4-methylphenol (C_7H_8O). Overall, S-nZVI offers a route to minimize persistent residues and shift FLX degradation toward less persistent and fully defluorinated products.