

Mitigating Micropollutants in Stormwater: Insights into Biochar-Activated Advanced Oxidation Processes

Abstract

Emerging micropollutants (MPs) in environmental matrices have attracted growing attention due to their adverse impacts on aquatic ecosystems. Stormwater has recently been identified as a significant source of MPs entering receiving waters, highlighting the urgent need for green stormwater infrastructure in megacities to enhance contaminant removal during stormwater harvesting and urban runoff. Biochar-based advanced oxidation processes (AOPs) have emerged as a promising solution for degrading MPs in various effluents. This study investigated the occurrence of 50 MPs—including 8 perfluorinated compounds (PFCs), 23 pharmaceuticals, 2 pesticides, 4 endocrine-disrupting chemicals, 7 nitrosamines, 2 corrosion inhibitors, and 4 preservatives—in stormwater canals and retention ponds. Concentrations ranged from 4.7 to 7,851 ng/L, with pharmaceuticals, corrosion inhibitors, PFCs, and pesticides being the most prevalent. The study further explored degradation patterns of MPs in three biochar-based hybrid systems: biochar/Fe(VI), biochar/chloramine, and biochar/persulfate. Among these, the biochar/persulfate system demonstrated the most effective overall removal, while biochar/Fe(VI) showed enhanced degradation of endocrine-disrupting chemicals, and biochar/chloramine effectively degraded amine-containing MPs. Sole biochar exhibited strong sorption capacity for PFCs, whereas biochar/persulfate moderately accelerated their degradation. Overall, this work provides comprehensive insights into the occurrence, removal efficiency, and potential risks of MPs in urban stormwater. Incorporating biochar-based AOPs into stormwater infrastructure presents a practical strategy to mitigate MP migration into receiving waters through in situ remediation.

Keywords: Micropollutants; Stormwater runoff; Biochar; Advanced oxidation processes; Perfluorinated compounds; In situ remediation