ChemXpress
ISSN: 2320-1975

ChemXpress

Editorial|Vol 13 Iss 2

Advanced Oxidation Processes Using Sulfate Radicals for Water and Wastewater Treatment

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Received date: May 06, 2021; **Accepted date:** May 11, 2021; **Published date:** May 22, 2021

Abstract

Traditional biological treatment approaches do not function well in many industrial wastewater/natural water treatment procedures due to the high toxicity, non-biodegradable, and refractory chemical properties of such wastewaters, including the abundance of organic compounds. Since sulphate radicals have a high redox potential, a long half-life, and wide pH applicability, Sulphate Radical-Based Advanced Oxidation Processes (SR-AOPs) have been shown to offer an alternate strategy to removing refractory organic pollutants. However, because of their slow reaction rates, the oxidants Persulfate (PS) and Peroxymonosulfate (PMS) cannot self-decompose to create sulphate radicals.

Keywords: Wastewater; biological wastewater treatment; sulphate radicals; toxicity

Introduction

Creating efficient and cost-effective activation techniques to produce sulphate radicals for water and wastewater treatment and the removal of refractory organics has been a hot subject in recent years. Reporting on PS/PMS activation techniques, functioning processes, kinetics of sulphate radicals on organics elimination, and possible intermediates throughout the degradation process are the main points of the report.

Quinones and organic matter with quinone-like groups have been discovered to be useful as accelerators or activators in advanced oxidation processes. Based on the evaluation of the degradation of 15 monoaromatics, a quantitative structure-activity relationship model was developed, and the experimental findings indicated that the lower the degradation rate, the more negative atomic net charges on carbon atoms. In the quinone-activated persulfate system, compounds having a lower q-C (the greatest negative partial net charge on a carbon atom) are more readily oxidized.

For PS activation and Nitrochlorobenzene (NCB) degradation using a new heterogeneous oxidation system, Biochar supported Nano-Zero Valent Iron (BC/nZVI). In brief, the aqueous phase degradation kinetics of m-, p-, and o-NCB isomers were studied. The impacts of BC/nZVI composition, PS/(BC/nZVI) mole ratio, and NCB starting concentration on the oxidation performance were also investigated. The best operating conditions were determined to be a Fe/BC/PS mole ratio of 1:1:1 and an initial NCB concentration of 10 mg/L.

UV/PS was initially used to concurrently eradicate *Microcystis aeruginosa* (*M. aeruginosa*) and 2, 4, 6-Trichlorophenol (TCP) in bench scale studies to remove algae and micro-organic pollutants in natural water. Both *M. aeruginosa* and TCP were effectively eliminated during the UV/PS treatment, according to the data. TCP degradation was mostly caused by SO4 oxidation and UV direct photolysis, whereas *M. aeruginosa* removal was primarily caused by OH and UV direct photolysis. Under addition, in the presence of TCP, the clearance of released intracellular organics from algae cells was hindered. However, at high PS doses (>1.5 mM), the inhibitory impact may be overlooked.

Citation: Eleanor White. Advanced Oxidation Processes Using Sulfate Radicals for Water and Wastewater Treatment. 2021; 13(2): 139

It was investigated that the decontamination kinetics of several target pollutants (benzoic acid, nitrobenzene, and trichloromethane) and oxidation by-products (bromate and chlorate) of three UV/peroxide procedures (UV/PMS, UV/PS, UV/H_2O_2). Under both acid and natural circumstances, UV/H_2O_2 was the most efficient system for benzoic acid and nitrobenzene degradation, while UV/PMS had the best removal efficiency under alkaline conditions. UV/PS was the most effective in removing trichloromethane at all pH conditions. In the foregoing three systems, the quantities of bromate and chlorate produced varied greatly depending on the aquatic environment. In addition, the degree of inhibition for the three UV/peroxide pathways was evaluated in the presence of common radical scavengers such as bicarbonate, carbonate, and Natural Organic Matter (NOM).