

Minimizing the interference of carbonate ions on degradation of SRF3B dye by Fe⁰-aggregate-activated persulfate process

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Carbonate ions in wastewater can interfere with the reactions in advanced oxidation processes. In the present study, the effects of carbonate ions on the degradation of a polyazo direct dye, the Sirius® Red F3B (SRF3B), using persulfate (PS) oxidation catalyzed by Fe⁰ aggregates (PS/Fe⁰) was investigated. Results of this study indicated that the oxidation power of the PS/Fe⁰ process was inhibited in the dye solutions containing carbonates, and the efficiency of SRF3B decolorization decreased with increasing concentration of Na₂CO₃. A short period of ultrasound (US) irradiation can significantly enhance the destruction of dye molecules. Complete decolorization of a 25 mg/L SRF3B solution containing 1 × 10⁻³ M carbonate, 5 × 10⁻³ M PS, and 1.5 g/L Fe⁰ was achieved within 5 min in a PS/Fe⁰/US system augmented with 5 min of US irradiation (60 kHz, 106 W/cm²). The operating cost to complete removal of the dye was estimated at 2.79 USD/m³. Higher PS dosage and US power further minimized the interference from carbonate ions. A two-step reaction model, including a slow surface heterogeneous and a fast homogeneous aqueous reactions was proposed for the system. The presence of Fe²⁺ and Fe³⁺ ions identified using X-ray photoelectron spectroscopy, suggests a direct oxidation of the dye on the surface of the Fe⁰ aggregates.

Keywords: Carbonate ions, Dye, Persulfate, Ultrasound, Zero-valent iron aggregates