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Degradation of Reactive Black 5 by ultrasound-activated persulfate process: kinetics, mineralization, and by-products

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ABSTRACT

The synergetic effect of medium-high frequency ultrasound (575–861–1,141 kHz) was tested to improve the removal efficiency and rate of a model recalcitrant compound namely Reactive Black 5 (RB5) from water. The optimum ultrasonic frequency and power conditions were found as 575 kHz and 60 W. Ultrasound was combined with various doses of persulfate (PS) and when combined with a 1:1,000 RB5:PS ratio 88% removal was achieved after 90 min under acidic conditions. Addition of Fe^{2+} to US:PS process speeded up the reaction and the reaction rate was increased from 0.0215 to 0.0541 min^{-1} with a 1:1,000:1 RB5:PS:Fe^{2+} ratio. PS consumption is greatest when the PS:Fe^{2+} process is applied (18%) however complete elimination of RB5 was not achieved until 90 min. On the other hand, PS consumption by US:PS:Fe^{2+} process was lesser and more stable within 60 and 90 min where almost complete elimination was achieved. Synergy index of US:PS:Fe^{2+} process was found 0.96 confirming that the process is a promising technique with lower consumption of oxidant and faster reaction rates. The optimum US:PS:Fe^{2+} process resulted in 67% NPOC removal after 90 min and the identified by-products by LCMS spectra were also listed. Treated samples showed severe toxicity on gram-negative bacteria namely *Escherichia coli* compare to gram-positive *Bacillus subtilis*.

Keywords: Textile wastewater treatment; Persulfate oxidation; Ultrasonic irradiation; Reactive Black 5; Mineralization

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