Reductive transformation and enhancement in biodegradability of mono-azo dye by high carbon iron filings (HCIF)

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ABSTRACT

In the present study, reductive degradation of commercially used mono-azo dye, C.I. Acid Orange 7 (AO7), has been investigated using high carbon iron filings (HCIF) in batch reactors. Extent of dye degradation was monitored on the basis of removal efficiencies of various parameters like color and chemical oxygen demand (COD). Enhancement in biodegradability of AO7 dye was evaluated on the basis of an increase in BOD5 and BOD5/COD ratio. The effect of different operating conditions, namely, initial pH, HCIF dosage, and initial dye concentration, were evaluated at mixing intensity of 30 rpm for 120 min. More than 90% decolorization was achieved at all experimental conditions studied. Optimum decolorization efficiency of 99.55% was achieved at pH 3 using HCIF dosage of 28.56 g/l and 100 mg/l initial AO7 concentration. In the adsorption experiments carried out at different initial dye concentrations, a significant amount of unreduced dye remained adsorbed onto the HCIF even after 120 min of reaction time, thus, decreasing the actual reduction efficiency. Under the optimal reaction conditions, COD removal efficiency of 64.71% was observed. The biological oxygen demand (BOD) for 100 mg/l AO7 dye solution increased from 2.32 mg/l of the untreated dye solution to 27.84 mg/l after 120 min. Biodegradability measured as BOD5/COD ratio was increased significantly from 0.0136 of the original solution to 0.464 after 120 min. First-order dye degradation kinetics was evaluated at different operating conditions. In experiments conducted at different pH, highest degradation constant ($k_{obs}$) of 1.40 min$^{-1}$ was recorded at pH 3. $k_{obs}$ increased linearly with increase in HCIF dosage whereas highest surface area normalized rate constant ($k_{SA}$) of 0.0495 l/m/ min was achieved at 28.56 g/l HCIF dosage. The $k_{obs}$ decreased as the initial AO7 concentration increased, suggesting saturation of ZVI surface reactive sites. The results suggest that HCIF can be used as a promising pre-treatment method, for recalcitrant azo dyes during conventional treatment methods.

Keywords: Azo dye; Acid Orange 7 (AO7); High carbon iron filings (HCIF); Reductive decolorization; Adsorption; Biodegradability

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