Removal of cibacron black commercial dye with heat- or iron-activated peroxidate: statistical evaluation of key operating parameters on decolorization and degradation by-products

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ABSTRACT

Sodium peroxidate activated by ferrous ions and/or increased temperature to generate sulfate radicals was employed as an oxidant to decolorize cibacron black, a commercial azo dye formulation. The effect of operating conditions, such as dye concentration (10–100 mg/L), oxidant concentration (30–150 mg/L), Fe²⁺ concentration (0–100 mg/L), temperature (25–70 ºC), and reaction time (2.5–10 min), on the extent of decolorization was evaluated implementing a 2⁵ factorial design approach. Of the five parameters tested and their second and higher order interactions, statistically significant were the three individual concentrations as well as the interaction between iron and sulfate concentrations. With the exception of dye concentration whose effect on decolorization was negative, all other important effects were positive and an empirical mathematical model to describe the process was proposed. At the conditions in question, persulfate activation by iron was found to be more effective than that by heat. LC–MS analysis was also employed to identify likely transformation by-products; although individual structures could not be proposed due to the complex nature of the commercial formulation, several peaks corresponding to the original formulation as well as to the reaction intermediates were identified and their concentration–time profiles were followed.

Keywords: Azo dye; Activation; Factorial design; LC–MS; Sulfate radicals

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