Modeling of decolorization of synthetic reactive dyestuff solutions with response surface methodology by a rapid and efficient process of ultrasound-assisted ozone oxidation

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ABSTRACT

The present study investigates the results of decolorization of Malachite Green (MG), Reactive Black 5 (RB5), and Reactive Yellow 145 (RY145) in aqueous solutions based on a rapid and novel process of ultrasound-assisted ozonation. A Placket–Burman design (PBD) as a factorial design was used to quantify and screen the significant effects of the seven factors on decolorization efficiency: temperature (°C), initial pH, probe position (height from bottom of reactor, mm), reaction time (min), ozone concentration (g/L), mixing speed (rpm), and ultrasonic power (W). Probe position and mixing speed were not found as significant after considering the regression and ANOVA results of PBD. A Box–Behnken design (BBD) as a kind of response surface methodology, with remaining five factors at three levels was set to demonstrate the interactions. The best-fit multi non-linear regression (MNLR) models were derived by using the results of BBD. According to BBD, the maximum decolorization efficiency of 99.31, 99.86, and 99.52% were obtained consistently at the lowest initial pH of 2, the highest reaction time of 30 min, and ozone concentration of 0.15 g/L for MG, RB5, and RY145, respectively. The best-fit MNLR models were cross-validated ($R^2_{pred}$) accounting for 81.02–88.25% and were expressed ($R^2_{adj}$) accounting for 93.01–95.70% of variation in decolorization efficiency.

Keywords: Decolorization; RSM, Anova; Non-linear regression; Ultrasonic irradiation; Ozone oxidation