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Optimization and kinetic evaluation of reactive yellow dye degradation by solar photocatalytic process

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ABSTRACT

Response surface methodology (RSM) was applied based on the central composite design to find the optimum parameters for the degradation of reactive yellow (RY) dye in an aqueous solution using a solar-induced photocatalytic process. The independent variables considered were pH, TiO_2, H_2O_2, initial RY dye concentration, and irradiation time. Optimization of parameters was performed by analysis of variance (ANOVA). In addition, a polynomial multiple regression equation was suggested as a model for the prediction of RY dye elimination percentage. The results show that the RY dye removal at the optimal conditions of pH 6.95294, TiO_2 concentration 25.5441 mg/L, H_2O_2 concentration 383.676 mg/L, RY initial dye concentration 20.9412 mg/L, and irradiation time 89.6176 min was 91%. The ANOVA presents the coefficients of determination were R^2 = 0.9259 and R^2_{adj} = 0.9147, which confirm a satisfactory adjustment of the second-order regression model with the achieved data. Also, the results confirm that the removal percentage of RY dye follows a pseudo-first-order kinetic model with $R^2 > 0.92$. This study suggests that sunlight, catalyst, and H_2O_2 together have a significant effect on the degradation process, and under optimum operating conditions have a reasonable efficiency in the degradation of RY dye. Further, RSM was a suitable technique for the optimization of the variables involved in RY dye removal through the photocatalytic process.

Keywords: Reactive yellow dye; Solar photocatalysis; Kinetic model; Response surface methodology; Desirability function

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