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Mechanism of oxidative decomposition of direct red 89 by Bi_2O_3/TiO_2 composite under visible light irradiation: effect of co-existing cations and anions and artificial neural network modeling of key factor

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ABSTRACT

In the present study, the Bi_2O_3/TiO_2 composite was successfully synthesized by the solvothermal method and used for photocatalytic degradation of direct red 89 (DR89) from aqueous solution under visible light and UV-C irradiation. The effects of influencing parameters including solution pH, Bi_2O_3/TiO_2 dose, initial DR89 concentration, reaction time, co-existing cations and anions, and persulfate (PS) dose were examined. Finally, the artificial neural network (ANN) model was developed for the prediction of the photocatalytic removal of DR89. The results showed that with increasing solution pH from 3 to 4, the DR89 degradation promptly enhanced from 33.8% to 54.4% and after that, vigorously declined to 2.5% at a pH of 8. In addition, the increase of Bi_2O_3/TiO_2 dose from 100 to 800 mg/L led to the DR89 degradation efficiency increase from 60.7% to 94.8%. It was found that for achieving a high DR89 degradation efficiency under visible light irradiation at 20 mg/L of DR89, the solution pH and reaction time should be 4 and 45 min, respectively. When PS was added in the photocatalysis process, the highest removal efficiency of DR89 was observed at PS dose of 2.5 mg/L under UV-C irradiation. The presence of co-existing anions in the medium inhibited the DR89 removal efficiency following a trend that $PO_4^{3-} > Cl^- > SO_4^{2-}$ and for co-existing cations was in the order of $Na^+ > Ca^{2+} > Mg^{2+}$. The decomposition of the DR89 obeyed the first-order reactions and the rate constant was 0.012 mg/L min. The correlation coefficient for ANN was calculated 0.993, confirming that the predicted data from the designed ANN model were in good agreement with the experimental data.

Keywords: ANN model; Bi_2O_3/TiO_2 composite; Co-existing cations and anions; Direct red 89

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