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Enhanced photocatalytic mechanism of hydroxyl radical formation in the composite reaction of TiO_2/oxidant for azo dye degradation

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ABSTRACT

In order to improve visible light-driven photocatalytic activity, two oxidants, potassium dichromate (Cr(VI)) and potassium permanganate (Mn(VII)) were combined with TiO_2 photocatalysis for the degradation of dye acid orange 7 (AO7). The assessments of photocatalytic activity including AO7 mineralization and hydroxyl radical (•OH) formation were measured by total organic carbon and coumarin probing with fluorescence, respectively. Based on the assessed results varied with different irradiation wavelengths and dissolved oxygen levels, the parametric effects and •OH formation trends were estimated to further propose the possible mechanisms. A highly positive correlation (r = 0.82) between AO7 mineralizations and •OH formations was observed. The •OH formation trends from valence band (VB) and conduction band (CB) sites on TiO_2 were nearly similar under ultraviolet irradiation, while those under visible irradiation were uneven (34% and 66% for VB and CB sites, respectively). Owing to the fact that Cr(VI) and Mn(VII) are electron acceptors, the total •OH formations were enhanced to 126% and 144% by increasing the utilization of original photogenerated electrons with their redox reactions. In the meantime, the hole–electron recombination could also be inhibited to benefit the photodegradation of AO7. This mechanism was slightly different from the general strategies for improvement of photocatalytic activity.

Keywords: Visible light; Oxidant; TiO_2; Hydroxyl radical; Photogenerated electron

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