The promoting effect of BrO_3^-, $H_2PO_4^-$ and PO_4^{3-} in photocatalytic degradation of methyl orange on TiO_2

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Abstract: The addition of anions(BrO_3^-, $H_2PO_4^-$, PO_4^{3-}) to TiO_2 can promote the degradation of MO due to the active species. The mechanism of BrO_3^-, $H_2PO_4^-$ and PO_4^{3-} on the photocatalytic degradation by TiO_2 was discussed, with isopropanol (IPA), sodium formate (SF), benzoquinone (BQ) as scavengers for hydroxyl radicals (•OH), positive hole (h^+), superoxide radicals(• O_2^-) radicals respectively. Results showed that the promoting effect of BrO_3^- on TiO_2 is mainly due to the oxidation capacity itself. As for $H_2PO_4^-$ system and PO_4^{3-} system, the promoting effect was mainly driven by the • O_2^- radicals.

Keywords: Titanium dioxide, Anions, Active species, Scavengers.

1.Introduction

Researchers have reported anions and cations owned the ability to promote or restrain the photocatalytic degradation(PCD) process by TiO_2[1-3]. Our group have already found that anions of BrO_3^-, $H_2PO_4^-$, PO_4^{3-} have positive effect on the PCD rate of MO under UV light[4]. The PCD rate of MO by TiO_2 was driven mainly by the participation of reactive radicals such as •OH, h^+• and O_2^-[5]. In our work, we briefly discuss the promotion mechanism of the PCD rate of MO by TiO_2 with BrO_3^-, $H_2PO_4^-$ and PO_4^{3-}, which IPA was used to capture •OH, SF was used to capture h^+, BQ was used to capture • O_2^-.

2.Experimental

The photocatalytic process was carried out with photochemical reaction instrument (BL-GHX-V, Shanghai Bilang Instrument Co., Ltd.). The light source was 300W mercury lamp which simulating UV light, the distance from the center of the light to the quartz reaction tube was about 12 cm. The degraded solutions were analyzed using 722G spectrophotometer (Shanghai Precision Science Instrument Co., Ltd) to determine its absorbance.

3. Results and Discussion

Anions, BrO_3^-、$H_2PO_4^-$ and PO_4^{3-}, their own effect of anions on the degradation of MO solution were texted, and shown in Fig.1. The

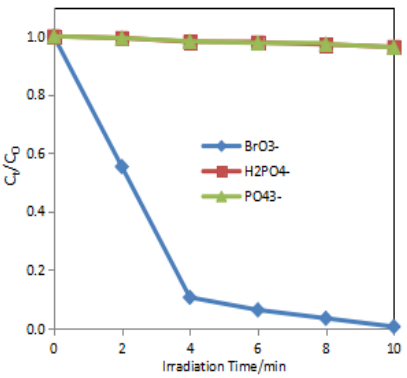

Figure.1 The effect of anions on MO

degradation rate was reached 99.4% at 10min, nearly 100%, since it is an outstanding oxidant the BrO_3^- ion itself.

The effect of •OH, h^+, and • O_2^- radicals on photocatalytic degradation was studied respectively by adding IPA, SF and BQ into solutions of $H_2PO_4^-$ system, which shown in Fig.2. In the $H_2PO_4^-$ system, the addition of IPA, SF and BQ inhibited the degradation of MO, indicating that •OH, h^+ and • O_2^- played a role in the MO degradation process, and the intensity of the three was arranged as: • O_2^-＞•OH＞h^+, • O_2^- was the main active specie.

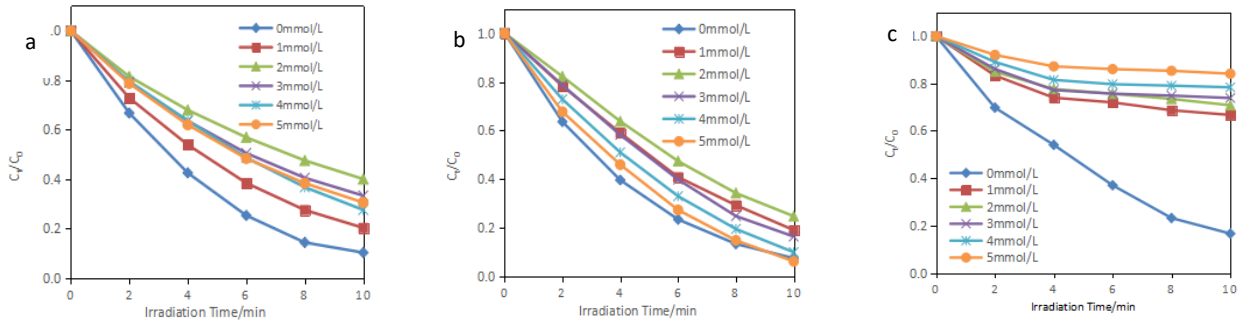

Figure.2 $H_2PO_4^-$ system with IPA(a), SF(b) and BQ(c)

From Fig.3, in the PO_4^{3-} system, the addition of BQ inhibited the degradation of MO, but there were no obvious effect observed to the PCD rate with the addition of IPA and SF. The enhancement of degradation has been attributed to the • O_2^- radicals.

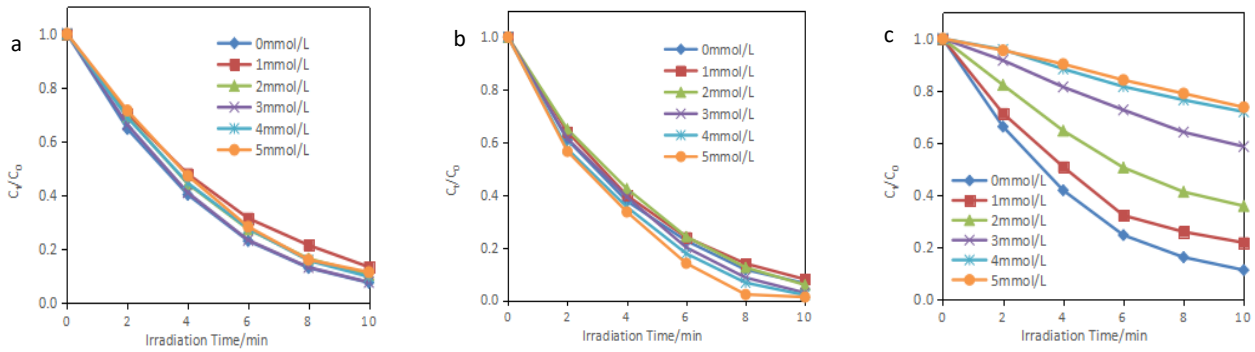

Figure.3 PO_4^{3-} system with IPA(a), SF(b) and BQ(c)

4.Conclusion

The promotion mechanism of BrO_3^- on MO oxidation by TiO_2 attributed to its own extremely strong oxidizing. And the promotion mechanism of $H_2PO_4^-$ system on MO oxidation was driven by the participation of •OH, h^+, and • O_2^- radicals, mainly owing to • O_2^-. While in the PO_4^{3-} system, the • O_2^- radicals played a catalytic role to the degradation promotion.

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