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Improved activation of peroxymonosulfate with $NaBH_4$-treated transition bi-metal oxide catalysts for Reactive Yellow 86 decolorization

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INTRODUCTION & AIM

○ Dyes are persistent and toxic. Wastewater containing dyes from the textile and dye industry is a serious source of water pollution.

Advanced oxidation processes (AOPs) can remove organic pollutants by producing reactive oxygen species.

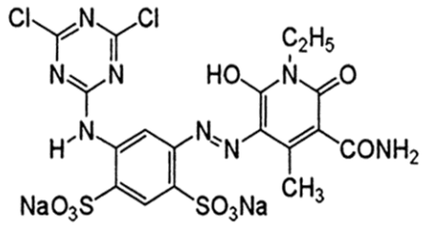


Fig. 1. Structural formula of Reactive Yellow 86.

○ In this study, we investigated the enhancement of peroxymonosulfate activation with $NaBH_4$-treated-$MnCo_2O_4$ for decolorization of Reactive Yellow 86, a type of dye.

METHOD

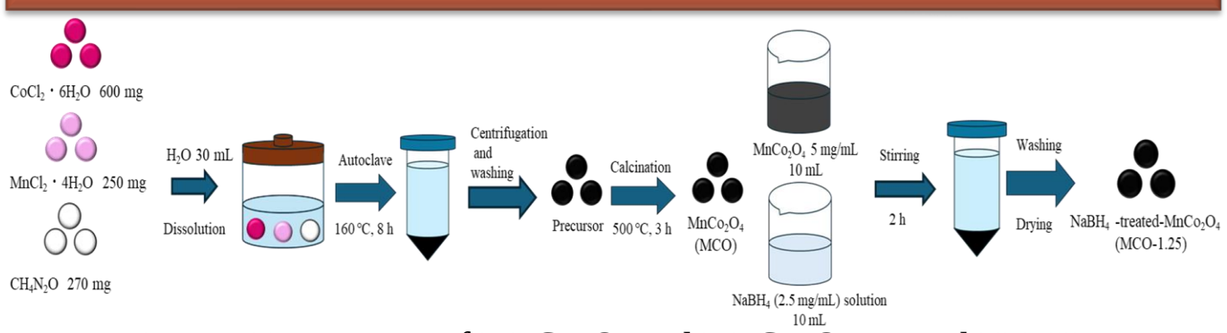


Fig. 2. Preparation of $MnCo_2O_4$ and $MnCo_2O_4$-treated $NaBH_4$.

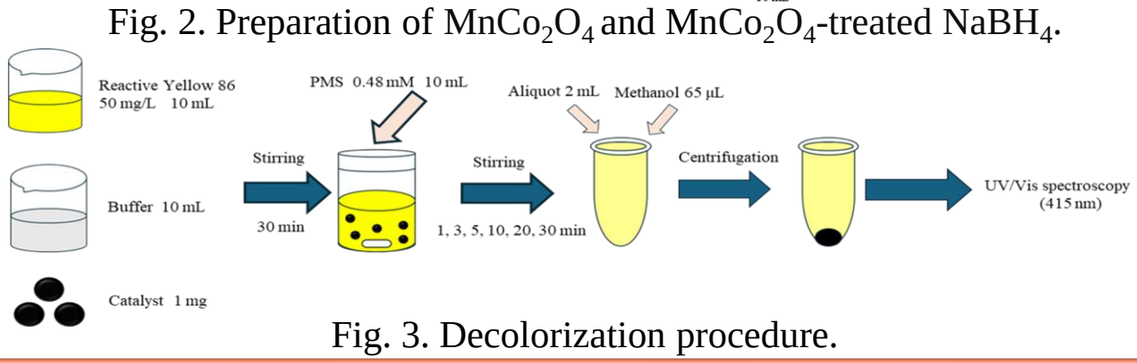


Fig. 3. Decolorization procedure.

RESULTS & DISCUSSION

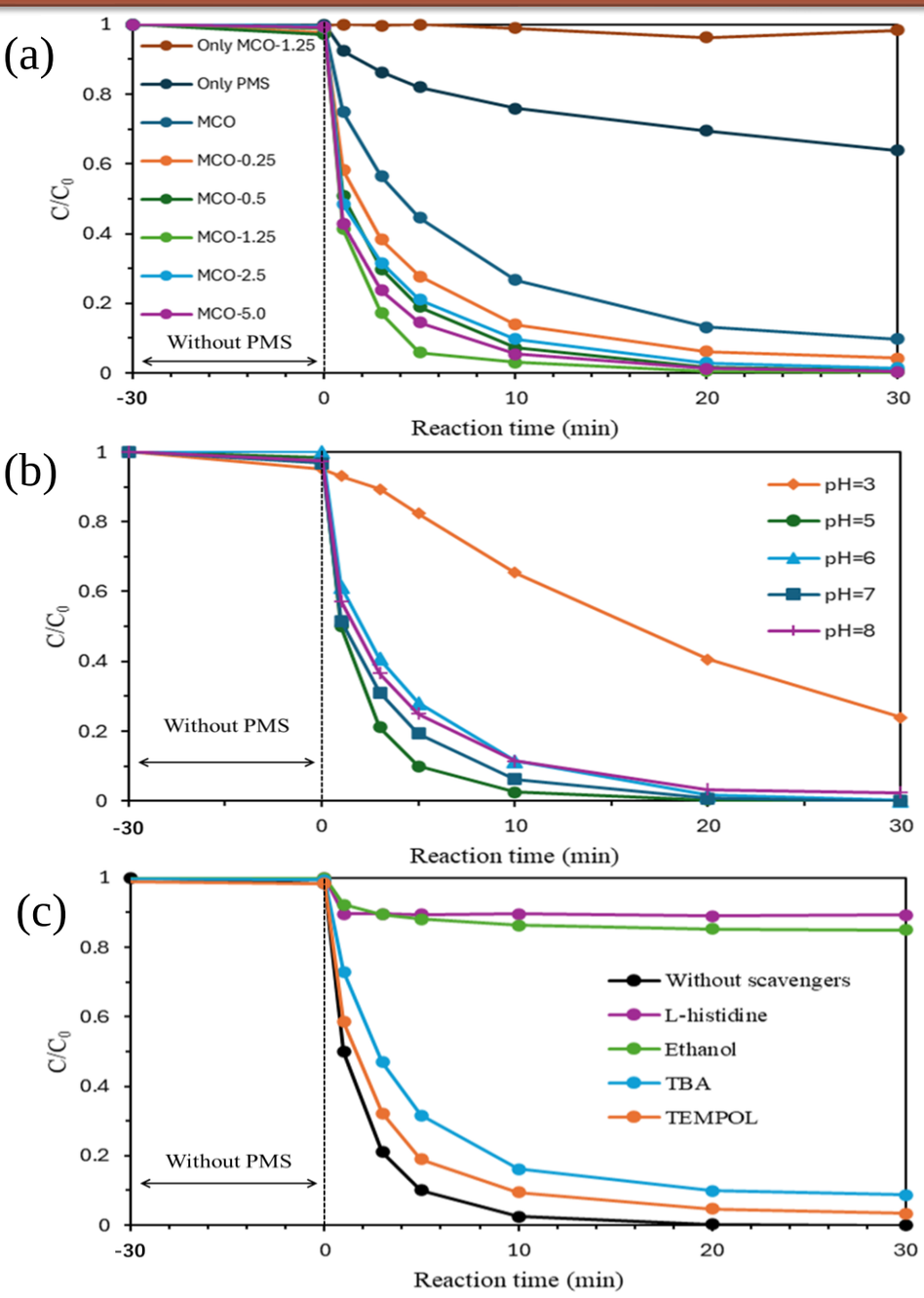


Fig. 4. (a) Decolorization of Reactive Yellow 86 (pH 7). (b) Effect of pH on the decolorization of Reactive Yellow 86 with MCO-1.25. (c) Effect of scavengers on the decolorization of Reactive Yellow 86 with MCO-1.25.

CHARACTERIZATION

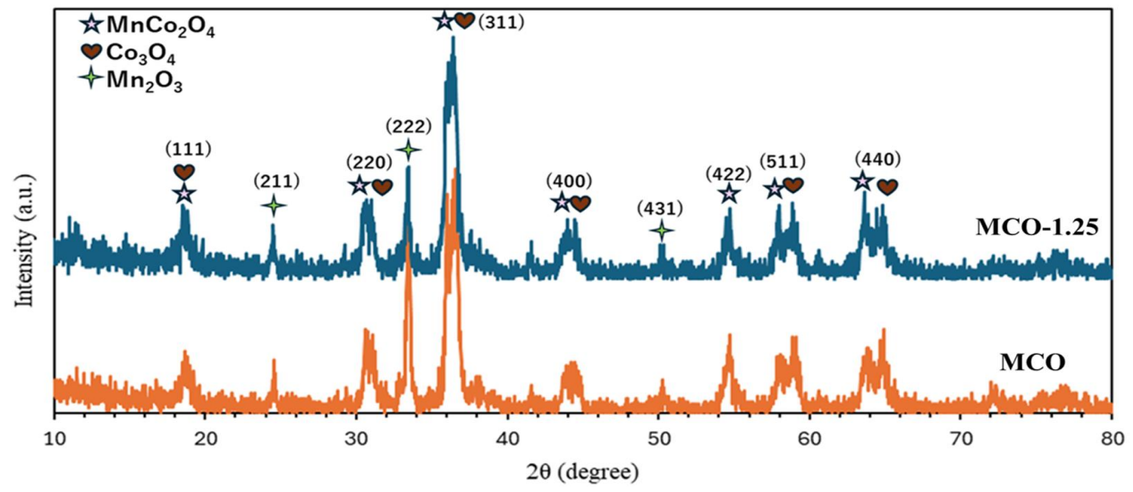


Fig. 5. XRD patterns of MCO and MCO-1.25.

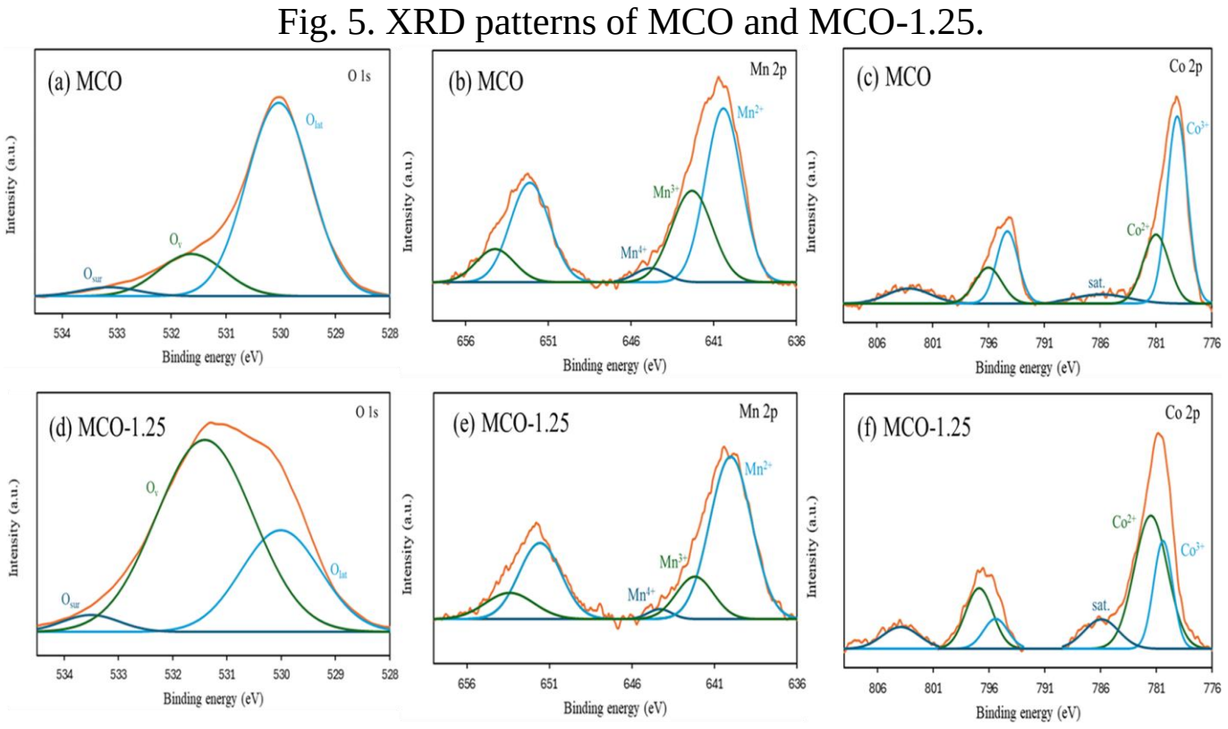
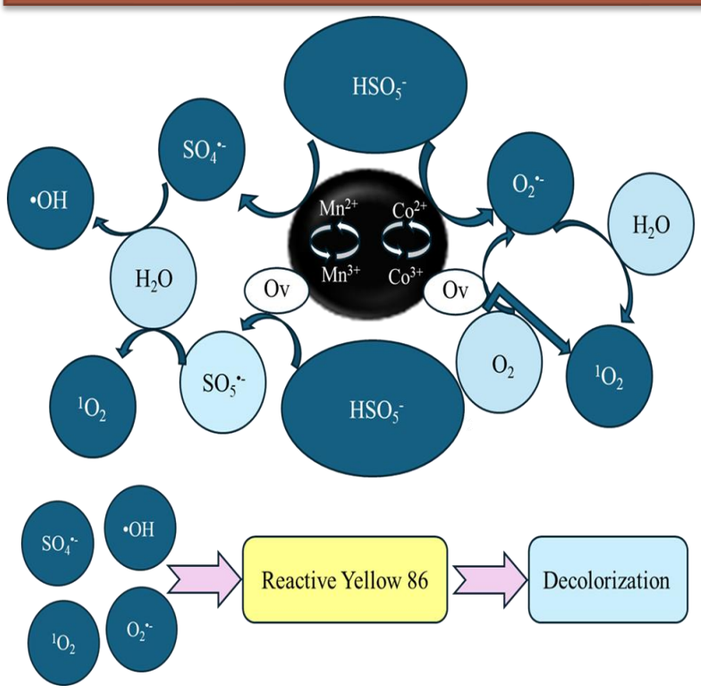


Fig. 6. XPS O 1s spectra of (a) MCO, (d) MCO-1.25, Mn 2p spectra of (b) MCO, (e) MCO-1.25, Co 2p spectra of (c) MCO, (f) MCO-1.25.

REACTION MECHANISM



$Mn^{2+} + HSO_5^- \rightarrow Mn^{3+} + SO_4^{\bullet-} + OH^-$ (1)

$Co^{2+} + HSO_5^- \rightarrow Co^{3+} + SO_4^{\bullet-} + OH^-$ (2)

$SO_4^{\bullet-} + H_2O \rightarrow SO_4^{2-} + \bullet OH + H^+$ (3)

$Mn^{2+} + 2HSO_5^- \rightarrow Mn^{3+} + 2SO_4^- + O_2^{\bullet-}$ (4)

$Co^{2+} + 2HSO_5^- \rightarrow Co^{3+} + 2SO_4^- + O_2^{\bullet-}$ (5)

$2O_2^{\bullet-} + 2H_2O \rightarrow {}^1O_2 + H_2O_2 + 2OH^-$ (6)

$Mn^{3+} + HSO_5^- \xrightarrow{Ov} Mn^{2+} + SO_5^{\bullet-} + H^+$ (7)

$Co^{3+} + HSO_5^- \xrightarrow{Ov} Co^{2+} + SO_5^{\bullet-} + H^+$ (8)

$2SO_5^{\bullet-} + H_2O \rightarrow 1.5\,{}^1O_2 + 2HSO_4^-$ (9)

$O_2 + 2e^- \xrightarrow{Ov} O_2^{\bullet-}$ (10)

$O_2 + 2e^- + Mn^{3+}/Co^{3+} \xrightarrow{Ov} {}^1O_2 + Mn^{2+}/Co^{2+}$ (11)

Fig. 7. Mechanism of catalyst activating PMS to decolor Reactive Yellow 86.

CONCLUSION

○ Under optimal conditions, Reactive Yellow 86 could be completely decolorized.

○ Oxygen vacancies (Ov), Co^{2+}/Co^{3+} and Mn^{2+}/Mn^{3+} contributed to the activation of peroxymonosulfate.

○ The radicals ($SO_4^{\bullet-}$, $^{\bullet}OH$, $O_2^{\bullet-}$, $^1O_2$) were able to rapidly decolorize Reactive Yellow 86.

REFERENCES

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2) Chengji Xu , Jianke Tan , Xiaodan Zhang, Yuming Huang Separation and Purification Technology, 291 (2022) 120933