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Case Study

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NOVEL ADVANCED OXIDATION PROCESS (AOPS) BASED ON PRE-MAGNETIZATION FE^0 FOR WASTEWATER TREATMENT

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Abstract

Novel advanced oxidation processes (AOPs) based on pre-magnetization Fe^0 was employed to enhance the degradation of organic pollutants and reduce reagents dosage. Compared with AOPs(Fe^0/H_2O_2, $Fe^0/K_2S_2O_8$) based on conventional Fe^0, AOPs based on pre-magnetization Fe^0 could have 1.4–51.1 folds enhancement in the degradation rate of different refractory pollutants. Meanwhile, the feasibility of pre-magnetization Fe^0/H_2O_2 was also better in salty system and practical wastewater. AOPs based on pre-magnetization Fe^0 is more promising and highly efficient processes since it does not require any change of the present water and wastewater treatment processes, and does not need an extra energy source and complex equipment.

Introduction

Nowadays, advanced oxidation processes (AOPs) have been regarded as good alternatives for the treatment of various recalcitrant organic pollutants. AOPs could degrade recalcitrant organic pollutants into less toxic products through the generation of highly powerful hydroxyl radical (·OH) or sulfate radicals ($SO_4^{\cdot-}$) via Eq. (1) and Eq. (2).

$$Fe^{2+} + H_2O_2 \rightarrow Fe^{3+} + OH^- + \cdot OH \quad (1)$$

$$Fe^{2+} + S_2O_8^{2-} \rightarrow SO_4^{\cdot-} + Fe^{3+} + SO_4^{2-} \quad (2)$$

Therefore, over the last decades, a large number of AOPs based on Fe^0 have been reported to remove different organic and inorganic pollutants and showed that the release of Fe^{2+} can accelerate the removal rate of pollutants. Therefore, some investigators adopted the integration of electricity, ultraviolet and ultrasonic to improve the generation of Fe^{2+} inducing the degradation of pollutants. However, these technologies would increase the costs for construction and operation.

In our previous research, it was verified that these AOPs based on pre-magnetization Fe^0 based on “magnetic memory” which defined as a period in which particles can sustain their

magnetization properties of certain intensity have miraculous improvement on organic pollutant degradation when comparing with conventional one, which would provide a more cost-effective alternative for environmental remediation[1]. The objects of this study is to (1) explore the characterizations of pre-magnetization Fe^0, (2) investigate the optimal value of f through response surface, (3) investigate the feasibility of AOPs based on pre-magnetization Fe^0 in salty system, (4) investigate the feasibility of AOPs based on pre-magnetization Fe^0 for re wastewater

Results and Discussion

As shown in Fig. 1, the application of pre-magnetization Fe^0 process had remarkable improvement. The degradation rate (*k*) of sulfadiazine(SD), tetracycline(TC), methylene blue (MB) and rhodamine B(RB) were improved greatly (Fig. 1) by pre-magnetization Fe^0/H_2O_2, and the value of *f* （rate constants between pre-magnetization process and conventional process）of these contaminants were 2.4 - 5.7. Therefore, pre-magnetization Fe^0/H_2O_2 could degrade a wide type of organic pollutants and accelerate the degradation of different pollutants.

Effect of common cations and anions in the pre-magnetization Fe^0/PS and Fe^0/PS processes were evaluated. Five cations(Mn^{2+}, Cu^{2+}, Mg^{2+}, Ca^{2+}, NH_4^+) and five anions(HCO_3^-, CO_3^{2-}, NO_3^-, PO_4^{3-}, HPO_4^-) were investigated. The corresponding results are shown in Fig. 2. As shown in Fig. 2, we could found that pre-magnetization Fe^0/PS process improved the degradation of RB in none of ions, each cations and each anions. Therefore, the feasibility of pre-magnetization Fe^0/PS process was better in different cations and anions.

Acknowledgments

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References

[1] Pan, Y., Zhou, M., Li, X., Xu, L., Tang, Z., Sheng, X., Li, B., 2016. Highly efficient persulfate oxidation process activated with pre-magnetization Fe^0. Chem. Eng. J. in press.

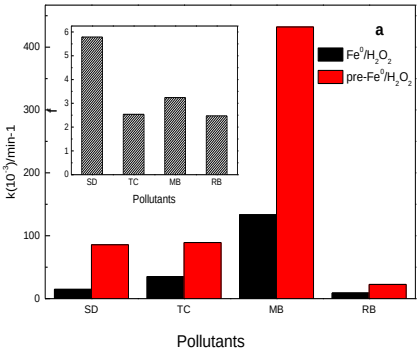

Figure 1: Pseudo-first-order rate constants of different pollutants by two processes

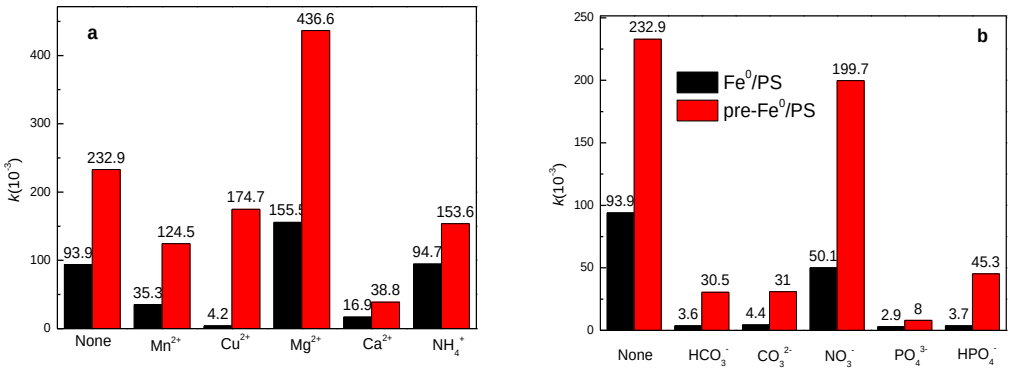

Figure 2: Pseudo-first-order rate constants at different cations (a) and anions (b)