Fe$_3$O$_4$ and Fe$_3$O$_4$/Fe$^{2+}$/Fe$^{0}$ catalyzed Fenton-like process for advanced treatment of pharmaceutical wastewater

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ABSTRACT

Batch experiments were conducted for advanced treatment of pharmaceutical wastewater (after biological treatment) in a series of Fenton-like systems. Fe$_3$O$_4$-H$_2$O$_2$ system had the highest reactivity for COD removal comparing to classic Fenton and Fe$_0$-H$_2$O$_2$ systems. Effects of crucial experimental factors were investigated, including H$_2$O$_2$ and Fe$_3$O$_4$ dosage, pH, and reaction time. To reach 20% COD removal, the optimal conditions were pH of 3.0, Fe$_3$O$_4$ dosage of 1.0 g/L, and H$_2$O$_2$ dosage of 10 mg/L. Comparing with the classical Fenton’s reaction, the Fe$_3$O$_4$-H$_2$O$_2$ system saved 75% H$_2$O$_2$, reduced 47% excess sludge, and slightly improved the COD removal. Furthermore, in order to meet the upcoming new local standard, Fe$^{2+}$ and Fe$^{0}$ were introduced into Fe$_3$O$_4$-H$_2$O$_2$ system to form a hybrid system, Fe$_3$O$_4$/Fe$^{2+}$/Fe$^{0}$-H$_2$O$_2$ (pH of 3.0, Fe$_3$O$_4$ of 1.0 g/L, Fe$^{2+}$ of 0.23 g/L, Fe$^{0}$ of 34 mg/L, and H$_2$O$_2$ of 40 mg/L). Fe$^{0}$ and Fe$^{2+}$ not only improved the COD removal and decreased iron sludge, but also enhanced the reuse of catalysts. Compared to the classic Fenton process, 80% H$_2$O$_2$ dosage was saved and 94% iron sludge was decreased. Meanwhile, the cost decrease by 1.66 RMB/m$^3$-wastewater.

Keywords: Fe$_3$O$_4$; Fe$^{2+}$; Pharmaceutical wastewater; Heterogeneous Fenton-like process

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