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Fenton Process for In-situ Treatment of Contaminated Groundwater

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1. Introduction

We used pseudo-continuous conventional Fenton oxidation to simulate electro-Fenton oxidation since in both processes the hydrogen peroxide is continuously added into the reactor and then consumed by the organic compounds. In this way, We can simplify the reaction model and make it easy to study the reaction kinetics of PCE, TCE, naphthalene and chloroform in aqueous solution using conventional Fenton oxidation with batch or continuous addition of hydrogen peroxide

2. Materials and Methods

2.1. Reagents: PCE, naphthalene, TCE

2.2. Stock solutions: Stock solutions of the selected organic compounds were prepared in a stirred glass flask, which was sealed by parafilm around the stopper in order to prevent organic vapor from leaking, by dissolving them into the double distilled water.

2.3. Chemical analysis: PCE and TCE; GC(HP-5890, SeriesII), Naphthalene; GC/MS(HP-5972 Serie)

2.4. Reactor design: A closed and zero head-space glass reactor with a total volume of 600 mL was used in this study in order to prevent organic vapors from leaking. In pseudo-continuous Fenton oxidation, a dosage pump was used to deliver H_2O_2(1%) at a rate of 0.575mL/min(or 0.336mM/min).

2.5. Fenton oxidation process: Batch Fenton oxidation experiments were conducted in completely mixed reactor under constant temperature(25℃), constant ionic strength(0.5M $NaClO_4$), and constant pH value.

3. Results and discussion

Results indicate that PCE, TCE and naphthalene can be decomposed rapidly and completely at a low dosage of Fenton's reagent. An approximately total removal was achieved for all compounds within 2-4 minutes at a specific dosage.

In the decompositions of TCE and naphthalene, both the hydrogen peroxide dos age and ferrous ion dosage exerted a great influence on the removal efficiency except that for the decomposition of naphthalene a little more time was needed to reach equilibrium. This result indicates that at a constant dosage of 1.5×10^{-3}M ferrous ion, there exists an optimal hydrogen peroxide dosage, i.e., 2.0×10^{-3}M.

Increasing the dosage will definitely increase the removal efficiency of chloroform. Similar results were obtained at different dosages of ferrous ion.

According to the result, it is clear that all reactions follow the first order kinetic expression. The kinetic constants and half lives of the decompositions of PCE, TCE and naphthalene by the pseudo-continuous Fenton oxidation are listed in Table 1.

Table 1. Kinetic constants, half-lives of PCP, TCE, and naphthalene .

Compound	k(sec^{-1})	$t_{1/2}$(sec)	R^2
PCE	1.37×10^{-2}	50.6	0.995
TCE	6.67×10^{-2}	103.9	0.991
Naphthalene	6.50×10^{-2}	106.6	0.967

$t_{1/2}$=half life, R=correlation coefficient

4. Conclusion

We investigated the optimal experimental condition and reaction kinetics on the decompositions of PCE, TCE, naphthalene, and chloroform with conventional Fenton oxidation. Additionally, the influence of pH on the decompositions of PCE was evaluated . Results indicate that the optimal pH value is around pH 3. The dosage of Fentoni¯s reagent and the molar ratio of hydrogen peroxide to ferrous ion for an approximately complete decomposition depend on the property of organic compound. Results show that PCE, TCE, and naphthalene can be all be effectively decomposed by Fentoni's reagent oxidation due to their unsaturated structures and an approximately total removal can be obtained at a low dosage and a certain molar ratio of hydrogen peroxide to ferrous ion.

References

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