

Microemulsion Approach to Nanoiron Production and Degradation of Trichloroethylene

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Abstract

In this study, metal iron nanoparticles were synthesized by the microemulsion method and used for dechlorinating trichloroethylene (TCE). Using the microemulsion method, nanoiron particles in the size range of 5~10 nm were produced. TCE up to a concentration of 100 mg/L was degraded.

1. Introduction

Nanoscale iron particles can be used in environmental remediation due to their small particle size and high specific surface area. Iron nanoparticles can be prepared by the solution method, the sol-gel method, thermal decomposition method and the microemulsion method. Microemulsions are thermodynamically stable complex fluids composed of water and oil domains that are separated by a surfactant monolayer, which reduces the unfavorable oil-water contact. Reverse micelles are of special interest because a variety of reactants can be introduced into the nanometer-sized aqueous domains for reaction confined within the reverse micelles, leading to materials with controlled size and shape.

2. Objective

The overall objective was to investigate the potential of using nanoiron particles to rapidly degrade TCE.

3. Testing Program

3.1 Characterization of Particles: The particles obtained using the microemulsion and solution methods were characterized using the JEOL 2000FX Transmission Electron Microscope (TEM) and Siemens D5000 X-ray diffraction (XRD).

3.2 TCE reduction: Experiments were conducted to investigate the reduction of TCE using the synthesized iron nanoparticles. Dechlorination of 20 mg/L and 100 mg/L TCE solution was investigated. The concentration of TCE was analyzed using the SHIMADZU GC-14A Gas Chromatograph.

4. Results and Discussion

4.1 Characterization of Iron Nanoparticles: Morphology of the particles was determined using the TEM image, as shown in Fig.1. From the TEM image, the particles synthesized by the microemulsion method were uniform in size and were less than 10 nm. Iron nanoparticles produced by this method were non-crystalline based on TEM and XRD results.

4.2 Reduction of TCE: Degradation of TCE with time by iron nanoparticles is shown in Fig. 2 and Fig. 3. The rate of degradation of TCE can be represented by a first order kinetic relationship as following:

$$dC/dt = -kC \quad (1)$$

where C is the concentration of TCE in the aqueous phase (mg/L), k is the dechlorination rate coefficient; hence the change in TCE concentration can be represented as

$$\ln(C/C_0) = -k t \tag{2}$$

where C_0 is the initial TCE concentration. This relationship is compared to the experiment results in Fig. 4.

Results indicated that the initial dechlorination rate coefficient (k) for microemulsion product varied with the initial TCE concentration and iron loading. Microemulsion product totally degraded 100 mg/L TCE in 105 hours when iron-to-solution loading was 5 g/L, but only degraded 35% TCE when the loading was 1.5 g/L.

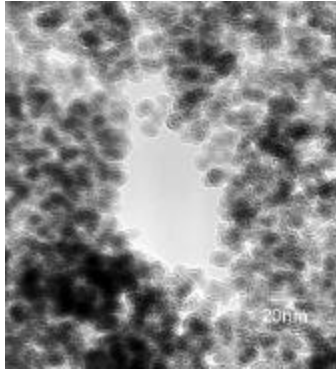


Fig.1 Transmission electron micrograph of nanoiron particles

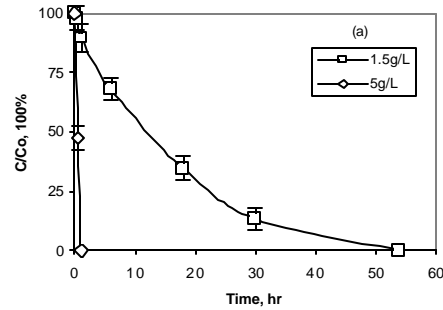


Fig.2 TCE degradation by nanoiron particles (TCE the concentration:20 mg/L)

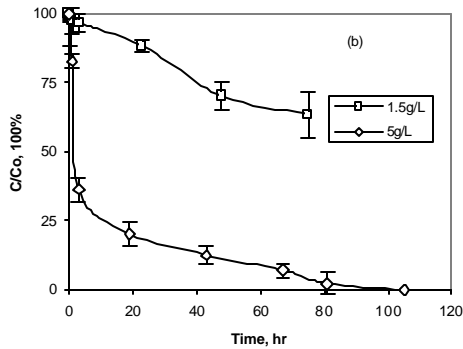


Fig. 3 TCE degradation by nanoiron particles (TCE concentration: 100 mg/L)

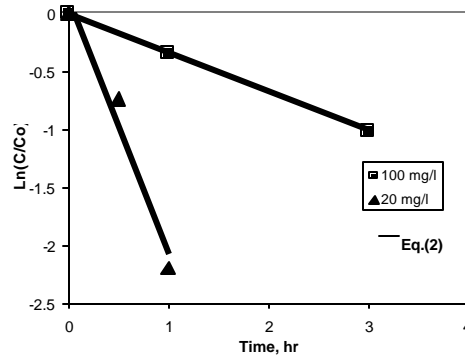


Fig. 4 Rate of TCE degradation by nanoiron particles: Iron to solution loading: 5 g/L

5. Conclusion

The microemulsion method can be used to produce nanoiron particles. The nanoiron particles were very effective in degradation of TCE.

6. Acknowledgement

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7. References

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