Microemulsion Approach to Bimetallic Fe/Ni Production and Degradation of Trichloroethylene

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Abstract: In this study, bimetallic iron-nickel nanoparticles were synthesized by the microemulsion method and used for dechlorinating trichloroethylene (TCE). Using the microemulsion method, nanoparticles less than 5 nm were produced. The nanoparticles were effective in degrading 10 mg/L of TCE in 15 minutes with metal loading of 3.5 g/L.

1. INTRODUCTION

Nanoscale iron particles have been used in environmental remediation due to their small particle size, high specific surface area. Bimetallic nanoparticles are more attractive here because of their ability to transform chlorinated compound faster by coupling iron to a less reactive metal, such as Pd, Pt, and Ni.

Reverse micelles are of special interests because a variety of reactants can be introduced into the nanometer-sized aqueous domains, leading to materials with controlled size and shape. In this study, Fe/Ni bimetallic particles were synthesized in the water-in-oil microemulsion system by the co-reduction of $FeCl_3$ and $NiCl_2$ with $NaBH_4$ at room temperature.

2.OBJECTIVE

The overall objective was to investigate the feasibility of using microemulsion method to synthesis iron-nickel particles, and determine their ability to dechlorinate TCE.

3.TESTING PROGRAM

3.1 Characterization of Particles: The particles obtained using the microemulsion method were characterized using the JEOL 2000FX Transmission Electron Microscope (TEM).

3.2 TCE reduction: Experiments were conducted to investigate the reduction of TCE using the synthesized iron-nickel nanoparticles. Dechlorination of 10 mg/L solution was investigated. Concentration of TCE was analyzed using the SHIMADZU GC-14A Gas Chromatograph.

4.RESULTS AND DISCUSSION

4.1 Characterization of Iron-Nickel 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 5 nm. Fe/Ni nanoparticles produced by this method was still amorphous based on TEM diffraction pattern.

4.2 Composition Analysis: The EDX results are shown in Fig. 2, which confirm the formation of Fe/Ni bimetallic nanoparticles. The experimental results showed that the average composition of products were in agreement with those of precursor solution.

4.3 Particles Size Analysis: The sizes of Fe and Fe/Ni bimetallic nanoparticles were compared. From the TEM results, it was found that Fe/Ni bimetallic nanoparticles were significantly smaller than the Fe nanoparticles(5~10 nm) at same reaction conditions[4].

4.4 Reduction of TCE: Degradation of TCE with time by Fe/Ni nanoparticles is shown in Fig. 3&4.

Fig.1 Transmission electron micrograph of the Fe/Ni particles

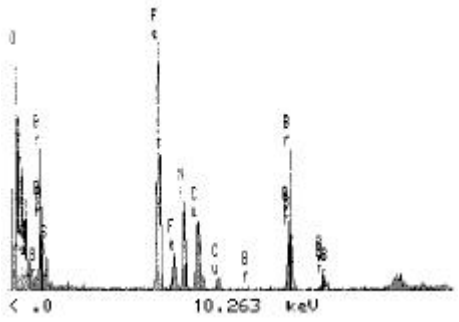

Fig.2 EDX of Fe/Ni nanoparticles (Fe/Ni mol ratio= 3:1)

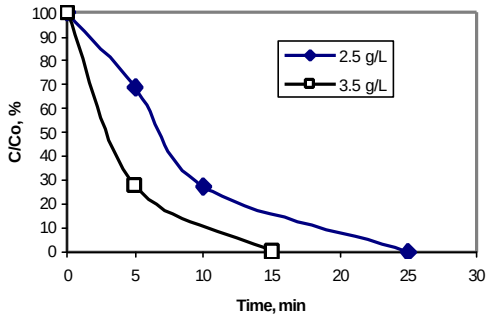

Fig.3 TCE degradation by iron-nickel nanoparticles (TCE concentration: 10 mg/L)

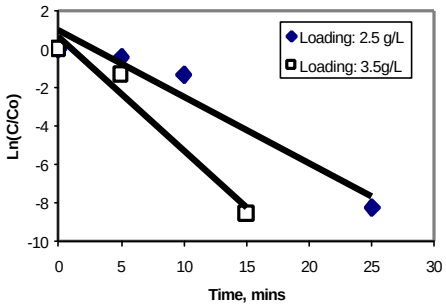

Fig.4 Rate of TCE degradation by iron-nickel nanoparticles (TCE concentration: 10 mg/L)

5.CONCLUSION

The microemulsion method can be used to produce Fe/Ni bimetallic nanoparticles with the size less than 5 nm. Theses particles were very effective in degrading TCE, the surface area normalized rate was 9.4×10^{-2} L $h^{-1}m^{-2}$.

6. ACKNOWLEDGEMENT

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7.REFERENCES

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