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Green Synthesized nZVI Enhanced Persulfate Oxidation of Petroleum Hydrocarbons

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Extended Abstract

Introduction

Nano-scale zerovalent iron (nZVI) is a critical component in reduction-oxidation (redox) processes with a characteristic role of enhancing reactivity (Greenlee et al. 2012). Recently, plant extracts has been used in the synthesis of nZVI by a bioreduction of ferrous salts (Hoag et al. 2009). We investigated the effect of persulfate oxidation of TPH in oily sludge contaminated soil activated by green synthesized nZVI (G-nZVI), commercial nZVI (C-nZVI), Magnetite NPs (nano-Fe_3O_4).

Methods

Aqueous solution of ferric chloride (0.05M $FeCl_3 \bullet 6H_2O$) was prepared and used for the synthesis of zerovalent iron nanoparticle. The synthesise was carried out with a drop-wise addition of 30 mL of the fruit waste extract into a 10 mL of aqueous solution of iron chloride and freeze dried. Characterization of the synthesized zerovalent iron nanoparticle was performed using SEM/EDX, XRD, X-ray photo-electronspectroscope (XPS), and FTIR spectrophotometer. To evaluate the catalytic role of G-nZVI, a series of batch experiments were conducted. Sieved oil sludge contaminated soil sample (2 g) was loaded in a 50 mL vial (as a reactor) mixing with 10 mL of persulfate initially and followed by addition of the activators (G-nZVI, C-nZVI, nano-Fe_3O_4). The experimental runs were performed at temperature of 20 ^{0}C on a rotating shaker under dark condition. Total petroleum hydrocarbon (TPH) was analysed using GC/FID.

Results

In this study, (nZVI) was successfully synthesized using fruit waste extract, which were characterized by UV-Vis, SEM/EDX, FTIR and XPS. The result showed the successful synthesis of nZVI with particle size of < 25 nm coated with an organic layer.

The rate of oxidative degradation of TPH in zero valent iron catalysed persulfate oxidation system was more pronounced compared to the nano-Fe_3O_4 activated. More or less similar effect was observed for C-nZVI and G-nZVI catalysed treatments after the 21st day treatment. TPH removal from the oil sludge contaminated soil using green synthesized nZVI demonstrated >90% degradation over one week treatment. Surface capping of the synthesized material (G-nZVI) could enhance activation. The capping through controlled release of ferrous ion compared to C-nZVI could possibly prevent scavenging of sulphate radicals.

Conclusions

Green synthesized nZVI showed better efficiency compared to C-nZVI and nano-Fe_3O_4 activated treatment. The cost of producing G-NZVI and the less environmental concern are an advantage in use than the chemically synthesized.

References

Greenlee LF, Torrey JD, Amaro RL, Shaw JM. 2012. Kinetics of zero valent iron nanoparticle oxidation in oxygenated water. Environmental science & technology 46:12913-12920.

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