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Synthesizing Emulsified Nano-Sized Zero Valent iron (ENZVI) for Degradation of Dense non Aqueous Phase liquid (DNAPL)

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ABSTRACT

1. Introduction

The dense non aqueous phase liquid (DNAPL) is one of important target contaminants because of its high toxicity and potentials of long-term contamination in soil and groundwater. Although PRB (Permeable reactive barrier) using zero valent iron (ZVI) has been applied for DNAPL removal, some limitations (thicker wall because of its low reactivity with DNAPL, reaction only with dissolved DNAPL, etc.) have been pointed out. To overcome these limitations, colloidal barrier using nano-sized zero valent iron (NZVI) was suggested. NZVI has higher reactivity due to the higher surface area and also can be injected directly into contaminated area, while it still has low accessibility to the residuals of DNAPL existing in vadose zone.

Recently, novel emulsified nano-sized zero valent iron (ENZVI) has been proposed. ENZVI has outer oil membrane and an inner water phase with NZVI. When ENZVI is injected and reaches to DNAPL contaminated area, hydrophobic DNAPL can be dissolved into the oil membrane. And it is diffused into the inner water phase and reacts with NZVI and degraded. Only limited work has been reported, there are a lot of factors affecting ENZVI synthesis such as oil/water/surfactant ratio, pH, temperature, mixing speed, etc. Therefore, the objective of this study will be to investigate the optimal ratio of oil/water/surfactant for ENZVI synthesis, and to evaluate its reactivity with tri-chloroethylene (TCE).

2. Material and method

NZVI was prepared by chemical reduction using $FeCl_3 \cdot 6H_2O$ and $NaBH_4$. A corn oil, NZVI-dispersed DI water, Span85 were used as oil phase, water phase and surfactant, respectively. Corn oil and Span85 were premixed and emulsified with NZVI-dispersed water. The amount of water varied from 10g to 50g, while Span85 was changed from 5g to 25g, in 50g of corn oil.

3. Results

Fig. 1 shows a typical microscopic image of ENZVI (15g of water, 20g of Span85, 300rpm) synthesized, water droplet containing NZVI in the oil continuum

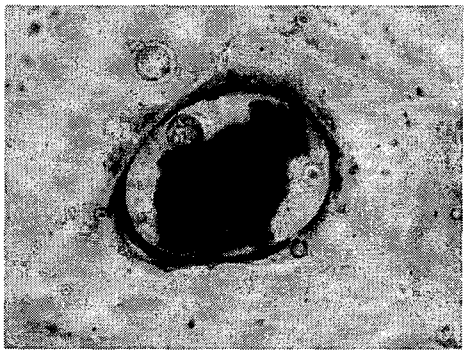
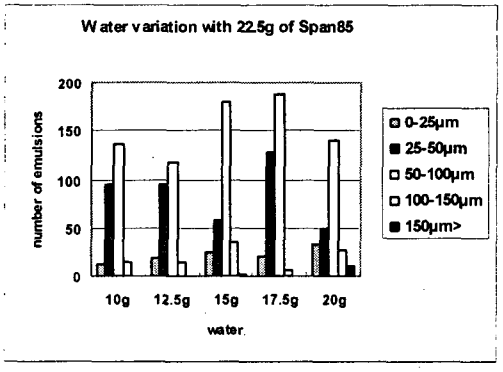


Fig. 1 Microscopic image of ENZVI

Figure 2(a) shows the effect of water content at constant amount of oil (50g) and surfactant (22.5g). It clearly shows that the number of emulsion increases with the increase of water content up to 17.5g, then decreases. The effect of Span85 content shows that high amount of Span85 (over 27.5 g) was not successful for ENZVI formation because the excess amount of surfactant resulted the formation of micelle. The formation of ENZVI was maximized at 22.5g of Span85.



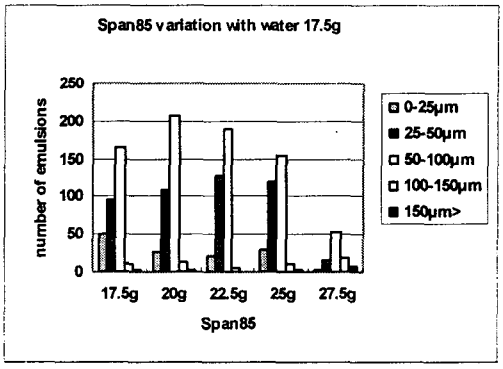


Fig 2. (a) Water content variation with 22.5g of Span85 (b) Span85 variation with 17.5g of water

Mixing speed also has significant effect on ENZVI synthesis. ENZVI could be synthesized at low (50rpm) and moderate (up to 300 rpm) mixing intensity. However, above 400rpm, the emulsion started to destabilized due to excessive energy dispersing NZVI into oil phase.

4. Conclusion

In this study, novel ENZVI for active removal of DNAPL in soil and groundwater is successfully

synthesized. The ratio and mixing speed have great effect on ENZVI synthesis. Through the experiment result, the ratio of 50/17.5/22.5 of oil/water/surfactant at 100 rpm of mixing intensity was optimal to synthesize ENZVI. The mobility and reactivity of ENZVI with TCE is in progress.

Key word : Nano-size zero valent iron(NZVI), TCE, DNAPL, Emulsification, Dechlorination