Enhancing Remediation of Residual DNAPL in Multilayer Systems: Injection of Alcohol-Surfactant-Polymer Mixtures

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Résumé

1 Introduction

For the remediation of DNAPL polluted soils, a well-known technique consists in the flushing of the contaminated aquifer by a polymer or surfactant solution (1). However, even after the initial flushing using these methods, there will remain some trapped DNAPL that cannot be further mobilized (2). Post-injection of alcohol-surfactant emulsion can result in higher recovery of DNAPL by solubilization or mobilization mechanisms (3). In the case of a multilayer system, recovering residual DNAPL from all layers after primary flushing can be challenging. In this study, we demonstrate how the injection of a mixture comprising alcohol, surfactant, and polymer can enhance the recovery of residual DNAPL in a multilayer system.

2 Methodology

The mixture employed consisted of two alcohols, 1-propanol and 1-hexanol. Xanthan, a biopolymer known for its non-Newtonian behavior in solution, and Sodium dodecylbenzene sulfonate (SDBS), a surfactant for stabilizing the mixture were used. Batch experiments were carried out with varying concentrations of the surfactant and volume fractions of alcohols, water, and DNAPL. To assess the effectiveness of the alcohol/polymer mixtures in recovering residual DNAPL, 1D-columns were used. Furthermore, the performance of these mixtures in improving multicomponent DNAPL recovery in multilayer systems was evaluated using a confined 2D tank of decimetric scale.

3 Results

The analysis of batch experiments reveals that the use of only 1-propanol as the remediating fluid leads to a decrease in the volume of DNAPL, indicating that solubilization is the

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primary washing mechanism. Conversely, the addition of 1-hexanol, regardless of the presence of 1-propanol, results in an increase in the volume of DNAPL. This demonstrates that the presence of 1-hexanol in the mixture influences the partitioning behavior of 1-propanol, leading to a mobilization mechanism. Density analysis of the samples obtained from displacement experiments in column and the tank shows that the mobilization mechanism can improve the recovery efficiency from 91% (achieved by primary flushing) to 99%, and from 86% to 94% for single-layer experiments in 1D column and multilayer experiments in 2D tank, respectively. The images obtained from 2D experiments demonstrate that in the case of the mobilization mechanism, a contaminant bank forms in front of the injected mixture in the flushed zone of the soil, as depicted in Figure 1.