CHAPTER I

INTRODUCTION

1.1 Introduction

The contamination of groundwater by organic solvents and other petroleum products has become a major environmental concern. The widespread use of petroleum hydrocarbon and chlorinated solvents has resulted in the contamination of valuable groundwater and soil. These compounds frequently enter the subsurface as a separate organic-phase or non-aqueous phase liquid (NAPL). The NAPL is transported downward due to gravitational and capillary forces which occur because of the interfacial tension (IFT) between the oil and water phases, causing oil droplets to be trapped in porous media (Pennell et al., 1996).

In general, there is often more than one type of NAPL oil contaminating the subsurface. The sources of contamination come from a variety of industrial activities such as chemical manufacturing, metal stripping and pesticide production; and accidental releases into the subsurface such as from underground or above-ground storage tanks, refineries, and transportation. Because the traditional pump and treat remediation (water-based flushing) is considered inefficient for these trapped oil phases, innovative methods have been developed to significantly enhance the extraction of residual oil saturation. This can be done in the following ways: (a) by increasing contaminant mobility and solubility to improve pump and treat performance, (b) by decreasing the mobility of contaminants to prevent its vertical migration, and (c) by speeding up the rate of the biodegradation of the contaminant in soil (Pennell et al., 1994 and 1996).

Typically, surfactant enhanced aquifer remediation (SEAR) is an effective method for the enhanced extraction of residuals of light non-aqueous phase liquids (LNAPLs). However, it may not be suitable for dense non-aqueous phase liquids (DNAPLs) due to the problem of vertical migration. Sabatini et al. (2000) have introduced a new approach, so called gradient approach, to maximize solubility enhancement while minimizing the vertical migration potential, and found it had a higher efficiency to remove DNAPL compared to the conventional SEAR method. Pabute (2005) studied this further by using the temperature gradient approach of a surfactant solution for the removal of different types of oil; e.g., decane and hexadecane stained on fabric in a batch study. The result showed that the temperature gradient approach had removed both oils slightly better than the fixed temperature for the whole washing experiment.

The concept of the gradient approach is based on flushing different surfactant mixtures at different salinities which provides different interfacial tensions between oil and the surfactant solution. From the change of the IFT, oil will become detached from the subsurface and subsequently, become trapped in micelles (Childs et al., 2004). This approach can then be efficiently used for DNAPL since it mobilizes the oil and traps the oil into micelles to eliminate vertical migration. Based on these criteria of the gradient approach providing different IFT, it is introduced to apply for contaminated subsurfaces with different light non-aqueous phase liquids (LNAPLs). It is expected that flushing the surfactant solution at a constant concentration would provide a certain IFT which may be efficient for one type of oil. As a consequence, in order to removal more than one contaminated oils, the surfactant gradient flushing which provides different IFT during the flushing may enhance several types of oil removal at the same time.

Diesel is one of the most important transportation fuels in the growing transportation industry around the world. The number of vehicles in use has been increasing rapidly resulting in an increasing amount of fuels usage. Diesel consumption is much higher than gasoline consumption. This may be because diesel provides more energy per unit volume than gasoline does. It is anticipated that diesel demand and utilization will still rise substantially in the next few decades (Song et al., 2000). Therefore, diesel use has a high possibility of contaminating soil and groundwater by leakage from gasoline stations or underground storage tanks. Aside from diesel, motor oil, which is a lubricant, is often found contaminated in the subsurface caused by the leakage from vehicles which use diesel engines such as trucks, trains, and buses especially at gasoline stations as well as garages. Therefore, the main objective of this study is to apply the gradient approach for diesel and motor oil removal in a column with a selected surfactant system by an increasing electrolyte gradient.

1.2 Objectives

The main objective of this study was to remove two types of oil, diesel and motor oil, from substrate using the surfactant gradient approach. The specific objectives were:

1. To investigate the phase behavior of systems enabled to form microemulsion with diesel and motor oil and to select the best surfactant systems for further use in a column study.
2. To apply the gradient approach from the selected system for diesel and motor oil removal in a column study using an electrolyte gradient.

1.3 Hypotheses

1. By using microemulsion formation, oily soil can be removed from the substrate due to the reduction of interfacial tension between oil and water in the subsurface.
2. Using the gradient approach along with varying an electrolyte of the selected surfactant system in continuous flushing can enhance diesel and motor oil solubilization and the removal of both types of oil in a column study at the same time.

1.4 Scope of the study

This study was divided into two parts: the phase behavior study and the column study. The phase behavior study was aimed to select the best surfactant system for further study in a column experiment. The phase behavior of the system was explained in terms of microemulsion formation as well as the interfacial tension (IFT) between equilibrated phases of each system. Then, the selected system from the phase behavior study was selected for experiments based on the gradient approach for diesel and motor oil removal in a column study using an electrolyte gradient. Ottawa sand at the mesh size 20-30 was used as the media in the column study.