CHAPTER 1

INTRODUCTION

1.1 Background of Study

Groundwater is one of the most important source of drinking water in the world. Therefore groundwater pollution is threatening as it will reduce the amount of drinking water to be used by a population of people. Groundwater pollution is usually referred to groundwater contamination whereby contamination occurs in the soil, which will affect the adjacent groundwater as the pollutants move laterally or vertically into the soil due to gravity through the vadose zone.

Soil contamination can be caused by any hazardous liquid, especially hydrocarbons which will either be attached or trapped in between the small pores in the soil particles (Francisca and Montoro, 2015). These contaminants are caused by the leakage of crude oil, spilling of hydrocarbon, oil refineries and gasoline from the pipelines. They are commonly referred as non-aqueous phase liquids (NAPLs) whereby they are liquid contaminant which will slightly dissolve or undissolved in the water.

According to Huling and Weaver (1991), NAPLs are the term used to describe regarding the differences between the physical and chemical characteristic of water and hydrocarbon liquids when phases formed which will divide the surface between the mixtures of the two liquids. Mostly, NAPLs of the higher percentage are made up of chlorinated solvents and petroleum hydrocarbons. NAPLs have been divided into two categories which are dense and light, based on their density. The first category is light non-aqueous phase liquid (LNAPLs) and the second category is dense non-aqueous phase liquid (DNAPLs).

LNAPLs such as toluene, kerosene and benzene, are the hydrocarbons that are less dense than water. They usually will mound, spread horizontally and move with the

groundwater gradient until it reached the water table's surface. Meanwhile, DNAPLs such as polychlorinated biphenyl (PCBs), trichloroethylene (TCE), creosote and coal tar (Bedient *et al*., 1999), are denser than water. They will mound, spread horizontally and migrate downwards to underlay the water table until it reaches the saturated zone (Brost and DeVaull, 2000). Due to their unique way of interaction with the soil, the need to detect them in the aquifer made the process relatively expensive and harder to remediate compared to LNAPLs.

1.2 Problem Statement

Water quality is one of the top most concerned problem in the world and it is important in order to provide a clean drinking water for people ensuring higher quality living. Chlorinated solvent, which is one of the of DNAPLs, is first produced in the 19th century in Germany (Pankow and Cherry, 1996) and due to its frequent use, the environmental contamination became a concern by 1970's. The reason is that migration of NAPLs will not only affect the condition of the soil and make the groundwater and soil become contaminated, but also will bring a negative impact as they are very toxic to all living things. Soil and groundwater, which have been contaminated will definitely affect human's health when they drink the contaminated water. The contaminated soil will also affect the growth of plants as it is toxic to the plants and the plants will either have stunted growth or wilt.

Therefore, it is important to further understand the flow of migration of NAPLs into the soil and groundwater. Many of the research that had been carried out to study the migration of NAPLs in the soil, had introduced a lot of method to be used in this study such as gamma radiation method (GRM) and X-ray attenuation method (X-RAM) which is categorized as photon-attenuation methods, light reflection method (LRM), light transmission method (LTM), multispectral image analysis method (MIAM) which categorized under photographic methods, ground penetration radar (GPR) and time-lapse three-dimensional Seismic (TL3-DS) which categorized under other imaging methods (Oostrom *et al*., 2007).

So, in this research, image analysis method will be used to produce the percent area saturated by NAPLs and also to analyze the result of different migration of NAPLs in different sand size layer. Digital camera and Image-Pro software will be used to

generate the image analysis in order to observe and differentiate the migration of NAPLs in the sand. Image analysis method actually had gained the attention of many researchers and is often used in determining the behavior of very small and tiny properties which cannot easily be seen by naked eyes such as porosity of the soil. Throughout this research, the types of flow of NAPLs can be categorized and determined by using this method.

1.3 Objectives

I. To investigate the flow pattern of NAPLs in sand with structured layers

II. To investigate the difference in LNAPL and DNAPL flow characteristics in soil with single porosity layered media

1.4 Scope of Study

The experiment for this research will be carried out in the Geotechnical Laboratory and Environmental Laboratory. The sand properties test is carried out and recorded before used in the experiment. Toluene liquid is used as LNAPL while trichloroethylene (TCE) liquid is used as DNAPL. Each NAPL experiment is repeated twice to verify the flow pattern of NAPL liquid in the sand layer. There are four levels of sand of different sizes with each having seven centimeters of height and placed in the acrylic model. Toluene liquid is poured slowly by using beaker into the sand and time taken for toluene to settle down each of the sand layer is recorded. The digital camera is used to capture the image and the data is processed by using the Image-Pro software. The same procedure is repeated again for the second time and is repeated for TCE. The migration of both NAPL in the sand will be studied and analyzed through the image captured and data processing from image software. The graphs of time taken for NAPL to reach the bottom of each sand size and percent area of each NAPL in the sand layer are then drawn and discussed.