ENHANCED SOLUBILIZATION BY SYNTHETIC AND BIOSURFACTANT ADDITION IN THE REMEDIATION OF PHENANTHRENE

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INTRODUCTION

Polycyclic Aromatic Hydrocarbons (PAHs) are hydrophobic and most are practically insoluble in water contributing to their persistence in the environment. In addition, most exist in strongly adsorbed forms when they are introduced into the soils. Their removal efficiency can be limited in low mass transfer phases, such as PAHs-contaminated soils, because most chemical and biological remediation technologies require transfer from NAPLs (Non-Aqueous Phase Liquids) into the mobile phase. Recent research has examined the possibility of enhancing the bioavailability of low solubility and highly sorptive compounds by the addition of solubilization agents, such as a surfactant, to the system. Recent research has examined the possibility of enhancing the bioavailability of low solubility and highly sorptive compounds by the addition of solubilization agents, such as a surfactant, to the system (Guha et al., 1998; Noordman et al., 1998; Wang et al., 1998; Li et al., 2001). The morphology of biosurfactant can be significantly affected by changes in pH. Previous research has shown the effect of pH on the surface tension and dispersion of organics (Zhang and Miller, 1992). Studies have investigated the morphology of rhamnolipid, a representative biosurfactant, as a function of pH change from lamellar, to vesicular and ultimately to micellar (Ishigami et al., 1987; Champion et al., 1995). The studies will be carried out to investigate the pH effect on solubilization of phenanthrene and sorption / desorption of phenanthrene by bio/surfactant in aqueous and soil-water system

MATERIALS AND METHODS

Solubility of phenanthrene. The solubility of phenanthrene in the biosurfactant solution was determined by batch tests. Phenanthrene (100mg) was added to 45ml centrifuge tubes along, with 20ml of deionized water with the biosurfactant at various concentrations. Samples were placed on an orbital shaker for 48 hours at room temperature. Samples were then centrifuged at 4000 rpm for 10 minutes, and the supernatant was analyzed by HPLC. One vial of each concentration was tested and nonionic surfactant, Tween 80 was also tested to provide a point of comparison.

Keyword: Rhamnolipid, pH effects, Bioavailability

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The effect of pH on solubilization of phenanthrene. The effect of pH on the solubility of phenanthrene in the surfactant solution was determined by batch tests. Phenanthrene (100mg) was added to 25ml centrifuge tubes and 20ml of the surfactant solution (240-mg/l) in deionized water at the various pHs was added. For experiment of solubilization in soil-water system, 2g of artificially contaminated sand with phenanthrene was added instead of phenanthrene particles. Triplicate samples were placed on an orbital shaker for 48 hours at room temperature (25°C). Samples were centrifuged at 4000 rpm for 10 minutes, and the supernatants were analyzed by HPLC.

RESULTS AND DISCUSSIONS

Phenanthrene Solubility. The solubility of phenanthrene increased significantly, up to 200 mg/l, in the presence of the surfactant (Figure 1). Tween 80, which is a chemically synthesized surfactant, showed greater solubilizing capacity than rhamnolipid. The solubilization capacity can be expressed as the MSR (molar solubilization ratio=moles of organic compounds solubilized per mole of surfactant). The calculated MSR of Tween 80 and rhamnolipid were 0.1449 and 0.0425, respectively (Figure 1).

Effect of pH on solubilization of phenanthrene. The highest solubility was detected at the pH 4 and the apparent solubilities at pH 4 with the 240-ppm rhamnolipid was 5.6 times greater than that at pH 7 (Figure 2). Changes in the apparent solubilities with the changes in pH are possibly related to the rhamnolipid, an anionic surfactant, forming different pH dependent structures. Also, in soil-aqueous systems, the solubilization capacity was also examined to confirm the effect of pH. The trends were consistent with the centrifuge vial results except pH 4 (Figure 3).

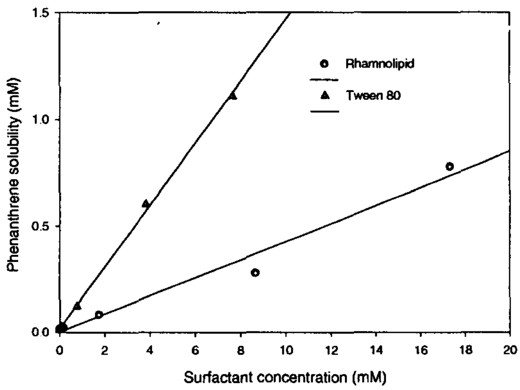

FIGURE 1. The relationship between the solubility of phenanthrene and the concentration of surfactants.

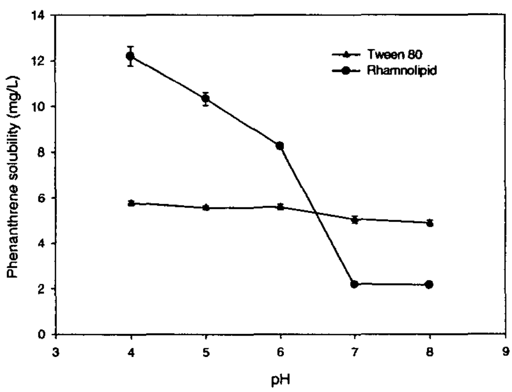

FIGURE 2. The effect of pH on phenanthrene solubility by Tween 80 and rhamnolipids.

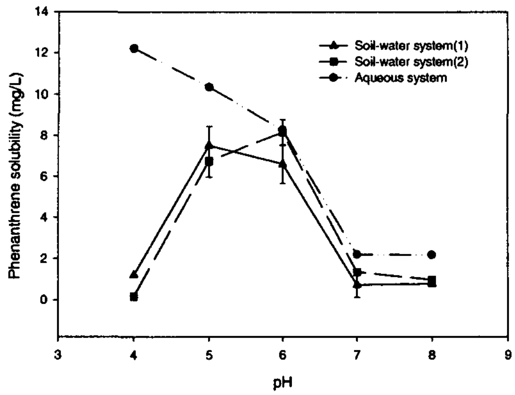

FIGURE 3. The effect of pH on phenanthrene solubility in soil-water system by Tween 80 and rhamnolipids.

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