Enhancing TCE Solubility by Biosurfactant Produced from Used Vegetable Oil

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Abstract
Using biosurfactant that produced from used vegetable oil by acclimated *Flavobacterium sp.* under non-sterile condition in remediating trichloroethylene (TCE), a dense non-aqueous phase liquid (NAPL) is being investigated. The biosurfactant is biodegradable and has a CMC of 0.2 g/L and lowered the surface tension of water to 28 dynes/cm. Using biosurfactant increased the solubility of TCE from 1000 to over 5000 mg/L.

1. Introduction
Remediation of aquifers and other groundwater contaminated by immiscle hydrocarbons is one of the greatest challenges encountered today. More and more evidences indicated that conventional pump-and-treat techniques are inadequate and insufficient to clean up these sites for their lower solubility, high density, and capillary forces arising from interfacial tension between the DNAPLs and water (EPA, 1999). Though using chemically produced surfactants flushing has shown promise for significantly reducing the time and cost of remediation, the use of these surfactants in environmental treatment processes has been rather limited due to the concerns regarding their toxicity and biodegradation fact. Biosurfactant are biologically synthesized surface-active agents. They are extracellular macromolecules produced as metabolic byproducts of microbial transformation of organic substrate. Biosurfactant, have the advantages of being readily biodegradable and posses properties comparable to chemical produced surfactants, can be used for various applications. This distinct perspective makes it valuable in cleaning up DNAPLs.

2. Objective
The overall objectives of this study are to produce biosurfactant from used vegetable oil and apply them in remediating of NAPLs contaminated sites. Specific objectives are (1) to produce biosurfactant from used vegetable oils under non-sterile conditions; (2) to characterize biosurfactant through surface tension, critical micelle concentration (CMC), and critical micelle dilution (CMD); and (3) to investigate the role of biosurfactant in solubilizing TCE compared to chemically produced surfactants (Triton X-100 and sodium lauryl sulfate).

3. Testing Program
Biosurfactant production. Used vegetable oils obtained locally were adopted as substrates for acclimated *Flavobacterium sp.* to produce biosurfactant under nonaseptic conditions. The broth was monitored for parameters such as surface tension, pH, ORP and the emulsification capacity during the course of production.
Emulsification capacity. Emulsification activity is determined by adding 2 mL of surfactant solution in 15-mL glass centrifuge tube and incremental amounts (0.2 mL) of DNAPLs are added to the sample. The mixture is mixed for about 10 seconds using the vortex mixer. The sample is let

to stand still for 2 minutes and visually inspect for emulsion layer formation. If an emulsion layer exist the assay is repeated with addition of further increments of DNAPL phase.

Solubilization study. Solubilization enhancement is determined by adding 0.5-mL of DNAPLs in 40-mL glass vial with various amounts of surfactant in it. The reactors are mixing on shaker platform at 200 rpm at room temperature. The analysis of DNAPLs is followed the EPA method by using a gas chromatography (GC) with a FID detector.

4. Results

Biosurfactant production. The biosurfactant produced under nonaseptic and aseptic fermentation had similar characteristics. The surface tension of broth was reduced to below 29 dynes/cm after 24 hours of operation. The surface activity of the biosurfactant is mainly due to a proteinaceous component, and partly due to a sugar.

Solubilization of TCE. The solubility of TCE is increased from 1000 to over 5000 mg/L when 10 g/L of biosurfactant is used. The emulsification activity also indicates that biosurfactant has a comparable capacity to chemical surfactants such as SDS and Triton X-100.

5. Conclusions

(1) Biosurfactant produced from used vegetable oil reduces the surface tension of water to below 29 dynes/cm. The biosurfactant is produced during the growth phase.

(2) The produced biosurfactant increased the apparent solubility of TCE from 1000 to over 5000 mg/L when 10 g/L of biosurfactant was used.

6. Acknowledgments

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7. Reference

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