Surfactants to Enhance the Solubilization of Sulfate

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Abstract

Calcium, sodium, magnesium, and iron sulfates are the most common elements in soil and wastewater. The transformation of sulfate to hydrogen sulfide by sulfur-reducing bacteria will result in acid leachate and elevated levels of aluminum, iron and the heavy metals in the nearby environment. Using surfactants to enhance calcium sulfate solubilization will be investigated in this study. The calcium sulfate solubility increased by 1.5, to 1.1 and 1.2 times by UH biosurfactant, Triton X-100, and cetyltrimethylammonium bromide, respectively.

1. Introduction

The major sources of sulfate contamination are (a) industrial disposal (b) agricultural discharge and (c) natural sulfate bearing soils. Studies have shown that calcium, sodium, magnesium, and iron sulfates are the most commonly present sulfate salts in soil. Indigenous sulfur-reducing bacteria, which use sulfur as an energy source, could transfer sulfate to hydrogen sulfide and reduce the pH to below 4. Acid leachates, plus the aluminum, iron and the heavy metals, which it releases from soils, cause significant environmental and economic problems. It has been well established that the sulfate soils will attack the buried underground structures and cause long-term damage. There is a need to develop an effective treatment method for sulfate-rich soils.

2. Objective

The objective of this study is to explore the potential of using chemical and biological surfactants to enhance sulfate solubilization.

3. Testing Program

Surfactant. The surfactants under investigation were UH-biosurfactant, Triton X-100 (non-ionic), and cetyltrimethylammonium bromide (CTAB, cationic). UH biosurfactant was produced in the laboratory and chemical surfactants were purchased from Sigma Co..

Sulfate. Calcium sulfate ($CaSO_4$) obtained from Spectrum Quality Products, Inc. was used in this study. Its molecular weight was 136.14 g/mole, specific gravity of 2.96, and slightly soluble in water.

Solubilization test. The batch solubilization study was conducted by adding extra amounts of sulfate in various concentrations of surfactant solutions. Continuous stirring was done using a shaker at a speed of 220 rpm for up to 48 hours. After that, a sample was collected and centrifuged at a speed of 10,000 rpm for 10 minutes and was then analyzed for sulfate concentration in the supernatant.

Sulfate analysis. The sulfate concentration was quantified by using the AWWA method- 4500-Sulfate using spectrophotometer with a detection limit of 0.5 mg/L. The calibration curve for sulfate measurement is shown in Fig 1.

4. Results

Sulfate solubilization. Surfactants are effective in solubilizing sulfate, especially at high surfactant concentrations by complexing and/or micelle sorption. The calcium sulfate solubility was increased by 1.5, to 1.1 and 1.2 times by the UH biosurfactant, Triton X-100, and CTAB, respectively. The UH-biosurfactant showed better efficiency than Triton X-100 (nonionic) and CTAB (cationic) in solubilizing sulfate.

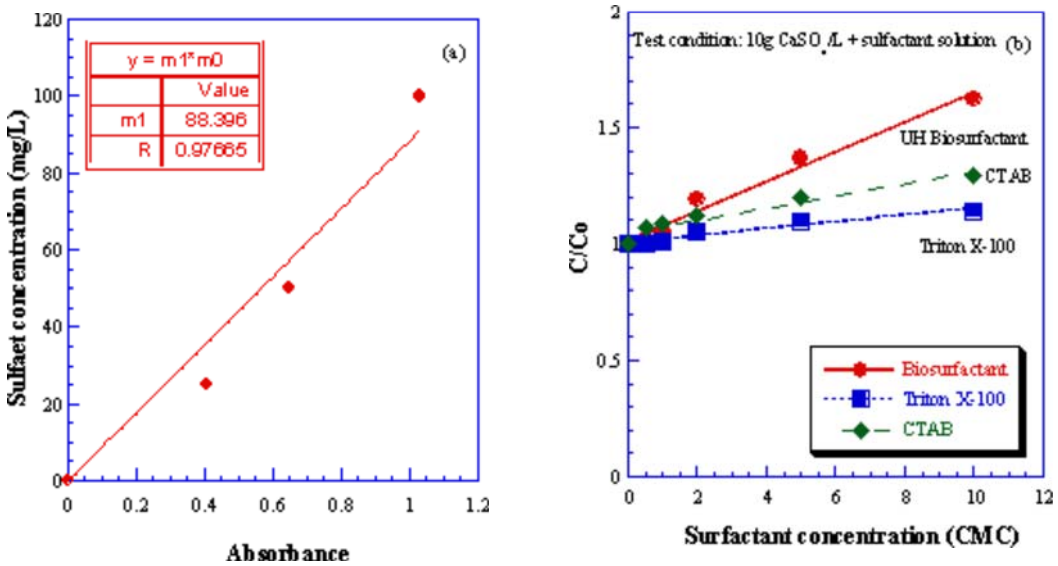

Figure 1. (a) Sulfate calibration curve; (b) Solubilization enhancement by surfactants

5. Conclusion

This limited study indicated that the UH-biosurfactant was effective in solubilizing calcium sulfate compared to Triton X-100 and cetyltrimethylammonium bromide.

6. Acknowledgments

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7. Reference

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