Effects of Surfactants on the Index Properties and Compaction of Clayey Soils

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Abstract

Effects of surfactant solutions on the index properties and compaction of kaolinite- and bentonite-clayey soils was investigated. Of the surfactants studied, SDS decreased the liquid limit and plasticity index of clayey soils. Maximum dry unit weights were increased and optimum moisture contents were decreased with SDS and biosurfactant.

1. Introduction

Contamination of groundwater with organics is a problem at many contaminated sites. Studies showed that sorption and diffusion of xenobiotic compounds within the soil matrix are critical processes affecting contaminant mobility, toxicity, and persistence. The use of surfactants, or surface-active agents, are being investigated as promising agents in enhancing the slow desorption and release of nonpolar organic compounds (NOCs) from the soil matrix to the aqueous phase and to accelerate the remediation efforts. One of the concerns in using surfactants for remediation is the potential to change the soil properties, either by changing soil structure or fluid characteristics. Any change in soil property might also create secondary contamination by the presence of surfactants, and furthermore, it might affect the in-situ remediation process. Moreover, a change in the geotechnical properties of the soil at the site could affect any further use after the clean-up process; hence, there is a need to characterize the interaction between surfactants and soils for a better understanding of the potential effects of using surfactants in the remediation process

2. Objective

The overall objective of this study was to investigate the effects of surfactants on clayey soils properties. The properties of interest are the Atterberg Limits and the compaction parameters of the selected soils.

3. Testing Program

Surfactant. Surfactants under investigation were UH biosurfactant, Triton X-100, and SDS. UH biosurfactant was produced by *Flavobacterium sp.* using vegetable oil as substrate. Chemical surfactants of Triton X-100 and SDS were obtained from Sigma and Fisher Co., respectively.

Clay. Both kaolinite (DBK Kaolin Co., Dry Branch, GA) and bentonite (Economy Gel Mud Product Co, Houston, TX) were used without any treatment. Two clayed soils used in this study were 30% kaolinite+70% sand (Soil A) and 30% bentonite+70% sand (Soil B).

Testing method. Relevant ASTM standard methods were used.

4. Results

Index property. The addition of SDS affected the index properties of kaolinite and bentonite (Table 1). Triton X-100 and biosurfactant had minimal effect on the index properties for both kaolinite and bentonite soils.

Compaction and strength. The addition of surfactants generally increased the maximum dry unit weight and decreased the optimum moisture content for both soils. Surfactants decreased the surface tension of water, making it a more efficient lubricant.

Table 1. Effect of Surfactants on the Atterberg Limits of Clays

Solution	Water	Triton X-100	SDS	Biosurfactant
LL (kaolinite)	47	48	30	47
PI (kaolinite)	18	17	7	15
LL (bentonite)	420	448	338	403
PI (bentonite)	386	405	288	359

5. Conclusions

(1) The addition of SDS decreased plasticity of test soils, however, the addition of Triton X-100 or biosurfactant did not affect the soil's index properties.

(2) The addition of surfactants generally increased the maximum dry unit weight and decreased optimum moisture content.

6. Acknowledgments

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7. Reference

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