Iranian Journal of Engineering Geology
Spring 2021, Vol.14, No.1

Improvement Of hydrocarbon contaminated sandy soils with MICP in reservoir

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Abstract

In addition to being a major environmental hazard and engineering hazard to nature, hydrocarbon contamination in contaminated sandy soil, reduces its strength parameters. There are many methots to refine and improve such contaminated soils. In the present study, the improvement of such contaminated soils by two types of hydrocarbons, including motor oil and gasoline, was performed using the Sporsarcina pasteuri strain bio-based injection method. and then calcium carbonate sequestration in a tank based on the gravity penetration of microbial improvers. The influence of hydrocarbon on the density and inhibitory effect on the exposure to microorganisms, using disk inhibitory test are investigated. These are the factors that affect the rate and mode of recovery and also improvement with any degree of success in hydrocarbon contaminated soils.The results of the improvement process were therefore investigated after injection and, obviously, due to the high inhibitory of the motor oil to the gasoline , the improvement process in this pollutant was less than that of the gasoline. Most bio-improvement also occurred in non-polluted soil.

Keywords: *Hydrocarbon contamination , Calcium carbonate sequestration , resistance parameter , Microbial improvement , Sporsarcina pasteuri*

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Extended Abstract:

1. Introduction

One of the most important geotechnical achievements in soil improvement is the use of sustainable methods in environmental issues. In MICP improvement, the bonding of soil masses with calcium carbonate, produced during the microbial process, increases the soil strength parameters (DeJong et al., 2010). On the other hand, soil contamination by motor oil leaks and derivatives may affect its physical, chemical and mechanical properties (Nasehi et al., 2016). In general, the presence of hydrocarbons, such as motor oil or gasoline, reduces the internal friction angle of granular soils (Abousnina et al., 2016), (Shin and Das, 2000), (Puri, 2000), (Ghaly, 2001), (Shin and Das, 2001), (Ratnaweera and Meegoda, 2005). Microbial methods for the improvement of hydrocarbon-contaminated soils were first performed in 2017 using bacterial flocs (Cheng and Shahin, 2017).
So far, in the hydrocarbon soil contamination, most attempts have been focused on the comparison of the strength parameters of contaminated and not contaminated soils with hydrocarbons. The microbial improvement in such soils, however, has not paid enough attention. Also, the distribution of pore fluid related to the bacterial suspension in contaminated soils has not been investigated. In the present study, in addition to examining the release of microbial improvement solution in soil, the amount of calcium carbonate produced at various depths, after injection and completion of the carbonation process in contaminated sand was measured for the first time. Disc inhibitory microbiology has been performed.

2. Materials and methods

In the present study, sandy soil (poured into a glassy tank) and two common types of hydrocarbon pollutants including motor oil and gasoline have been used as soil contaminants. Also, the Sporsarcina Pasteuri bacterial strain was employed to improve contaminated soil.
The process of microbial improvement in this study consists of bacterial strain injection into the soil through 8 points, 10 cm away from each other and a distance of 1.5 cm from the reservoir wall. After the bacterium entry of the (equivalent to 4 liters of bacterial suspension), it was abandoned for 120 minutes to reach its stabilization, followed by the cementation solution injection at the marked points.
After the improvement process, the following tests were performed:
1- Disc inhibition test to determine the sensitivity of bacteria to the pollutants, present in the culture medium
2- Direct shear test to determine the improved soil strength parameters
3- Chemical analysis to determine the amount of $CaCO_3$ formation at various depths. after the improvement process.

3. Tests results

According to the test results in table 1, it can be observed that motor oil is more inhibitor than gasoline and has some kind of antibiotic activity around it. This is due to the presence of a bright circle around the disk contaminated with motor oil with a diameter of about 12.5 mm, which is observed in the inhibition test.
Depending on the size of the inhibitory halo around the disc, it is possible to evaluate the microorganism against the contaminant with three categories including sensitive, moderate and susceptible (ClSI, 2009). Accordingly, Sporsarcina Pasteuri is classified as moderate and susceptible to gasoline and sensitive to motor oil. Pollutants are predicted to

be highly inhibitory, which alone could be an important factor in reducing the success of microbial recovery operations.
Increase of shear strength parameters has been reported in many studies after microbial improvement process. In this study, after microbial processes and the passage of 14 days, the samples were removed from under the depth of the improved soil and placed in the oven for 24 hours.dv

Table 1. Direct shear test results

C (kPa)	φ (°)	Sample code
0	38	Normal sand
630	52	S75
496	49	S50
33	20	M75
21	19	M50
17	29	G75
12	28	G50

To determine the amount of calcium carbonate formation produced, after each test, a sample was taken from different points to perform a more chemical test and the amount of calcium carbonate was determined. The highest percentage of mass produced was related to the injected surface of sand without contamination with a density of 75% to 12.9%.

4. Conclusion

- The dispersion and distribution of CaCO3 in sand is different with two different densities, so that in higher density sands, due to bacterial entrapment, in the initial injection, in the first layers, the sedimentation process is done quickly.
- The amount of sedimentation in the samples, contaminated with motor oil, is much lower than gasoline; Higher disc inhibition of motor oil than gasoline is the most important factor in this event.
- A significant increase in the magnitudes of strength parameters observed at the surface of samples with high density.
- According to the above results, the most important points that should be used for industrialization of biomass improvement method in contaminated hydrocarbon soils should be considered the following:
    1. The use of any reducing agent to prevent the inhibition of hydrocarbon substances against the microorganism of the optimizing agent,
    2. Using cheaper cultivation environments to create economic savings in the industrialization process,
    3. Investigating the effect of microorganism on the biodegradation of hydrocarbon components.

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