International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 07 Issue: 01 | Jan 2020 www.irjet.net p-ISSN: 2395-0072

Effectiveness of Saponin on Remediation of Used Motor Oil Contaminated High plasticity silt

Sachin Suresh C[1], Sruthi B Dharan[2]

[1]PG student, Dept. of Civil Engineering, Sarabhai Institute of Science and Technology, Kerala, India
[2]Assistant Professor, Dept. of Civil Engineering, Sarabhai Institute of Science and Technology, Kerala, India

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Abstract - Contaminants like heavy metals and aromatic hydrocarbons are found in Used Motor Oil (U.M.O.) as a result of reactions in motor engine. The presence of used motor oil in soil can adversely affect the geotechnical properties of the soil.. Contaminants in the form of saturated oily compounds are present in U.M.O. which can alter the geotechnical properties of the soil. In this paper a U.M.O. contaminated soil in the premises of a vehicle service station is treated by the method of Soil Washing using an eco-friendly surfactant called Saponin. The FT-IR analysis of the sample before and after washing is conducted to assess the effect of Saponin on removing the saturated compounds which otherwise act as contaminants. The spectrum obtained for washed soil showed no peaks formed in the region of alkanes and alkene functional groups indicating that saponin could remove the contaminants from the soil sample

Key Words: Used Motor oil, Contamination, Saponins, surfactants, FT-IR analysis

1. INTRODUCTION

The contamination of soil has become a serious environmental issue all over the world. Soil contamination can be defined as the presence of unwanted materials in it that causes the soil to lose its texture and imparts variations in the geotechnical properties. Change in soil properties resulting from contamination have been an area of interest for researchers for many years. In the recent past contamination of soil due motor oil/ engine oil has been reported many times. The used motor oil contamination is very common in areas near the motor mechanic workshops. Oil which no longer performs well after use due to contamination problem, making it unfit for its original purpose is known as Used Motor Oil (U.M.O). The engineering properties of U.M.O. contaminated soils are drastically changed and unsuitable for supporting engineering structures. Physical and chemical reactions occur during the working of motor and there is generations of impurities such as heavy metals e.g. zinc barium, chromium, copper, arsenic, calcium and aluminum. It also contains chlorinated and aromatic hydrocarbons e.g. benzene and toluene, Poly Chlorinated Biphenyls (P.C.B.) Dike B.U. et al., [1]. Due to the presence of U.M.O., the angle of internal friction (Φ) decreases and compression index of the soil increases. There is decrease in optimum water content, maximum dry density, Atterberg limits, permeability and cohesion; Otunyo A.W et al.,[3].

In this paper, removal of saturated oily compounds from Used Motor Oil Contaminated soil by the method of Soil Washing is studied. Soil washing by the use of an eco-friendly surfactant is carried out in this study. The surfactant used for the study is Saponin. Saponin is a plant derived natural non-ionic surfactant obtained from the seed shells of plant called Sapindus Mukorossi. FT-IR analysis of the washed sample is conducted for assessing the removal of saturated hydrocarbons and other contaminants from soil.

2. MATERIALS AND METHODOLOGY

2.1 Soil

A contaminated soil sample was required for the test. As required the soil used in this study was collected from the premises of a vehicle service station from a depth of 0.5m.

Table -1: Index properties of contaminated soil

Properties	Values
Specific gravity	1.61
Grain size distribution Clay (%) Silt (%)	 29 71
Liquid limit (%)	29
Plastic limit (%)	25.64
Plasticity index (%)	3.36
Maximum dry density (kNm^{-3})	1.8
Optimum moisture content (%)	18.5
Coefficient of permeability (cms^{-1})	$5.425*10^{-4}$
UCS (kPa)	14
Soil classification	ML

2.2 Saponin

The natural surfactant used for Soil Washing called Saponin was extracted from the outer shells of soap nut of the plant Sapindus Mukorossi. For this study soap nut is purchased through an online marketing firm. Initially the soap nut was broken down to get the shell separated from the seed. The shell is then subjected to grinding for extracting Saponin in powdered form from the shells. The saponin powder is then stored in an airtight bag.

Fig -1: Saponin

2.3 Soil Washing

A laboratory model of soil washing tank is constructed for the purpose of washing of the sample. Optimum concentration of Saponin is taken for washing the soil. Saponin solution was prepared by dissolving 60g of Saponin powder in 2Lof water. At a time 1 kg of soil is taken for washing. The soil surfactant mixture and water is taken in the container and the shaft of the washing system is centered exactly inside the container. The motor is switched on for the agitation of soil surfactant mixture to occur. The motor used has a speed of 960rpm. Higher the speed of rotation more is the adhesion between surfactant and soil. Inter particle contact will be more at higher speed of rotation. The duration of washing process is set for 20 minutes. After this period of rotation, motor is switched off and the mixture is allowed to settle for 1 hour for the filtrate to separate. After separation, the filtered soil alone is washed twice with water for the same duration at same speed of rotation. The washed sample is then subjected to air drying for 2 days. The FT-IR analysis of the sample before and after washing is done to assess the efficiency of Saponin in removal of the saturated oily compounds from contaminated soil sample.

Fig -2: Oil- Saponin mixture formed as foam at the top

3. RESULTS AND DISCUSSIONS

3.1 FT-IR analysis of contaminated soil

The FT-IR analysis of the contaminated soil is conducted to identify the contaminants present in the soil sample. The atomic spectrum of the contaminated soil sample obtained is shown below

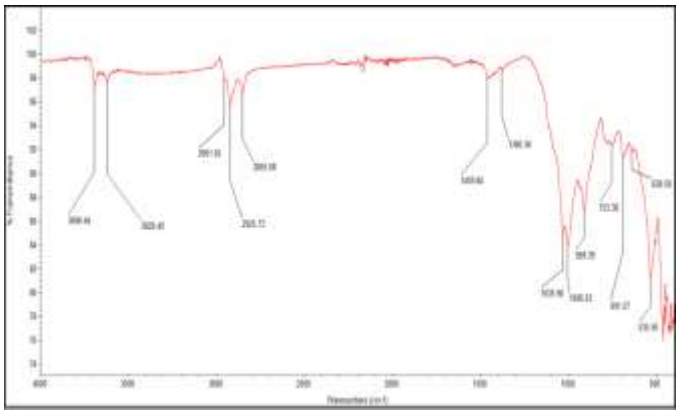

Fig -3: FT-IR spectrum of contaminated soil sample
(Source: SICC, Karyavattom)

The above figure shows the FT-IR analysis of contaminated soil. Peaks lying below 3000cm^{-1} shows presence of saturated hydrocarbons or alkanes. Region between 3100cm^{-1} 3600cm^{-1} indicates presence of alcohols, amines and carboxylic acid. Contaminants are mainly present in these regions with more of carboxylic acid as their functional group. The region lying between 2800cm^{-1}-2000cm^{-1} shows alkyne or nitrile group which also account for the presence of certain contaminants. The right half of the spectrum below 2000cm^{-1} has different peaks which are unidentifiable. Carbonyl groups lie between 1700cm^{-1}-1600cm^{-1}. So the soil sample was found to be contaminated badly by used motor oil.

3.2 FT-IR analysis of washed soil

The atomic spectrum of the washed soil sample is shown below

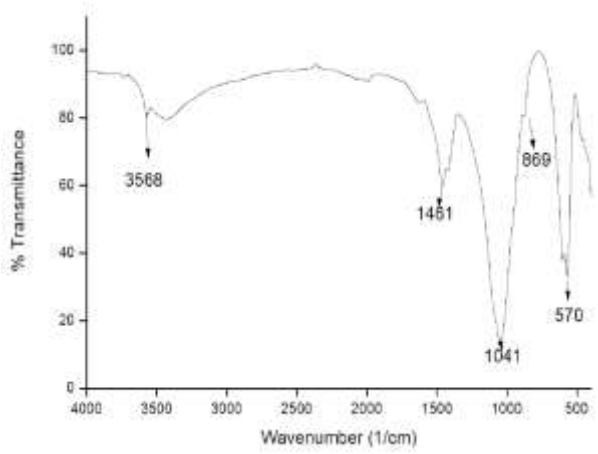

Fig -4: FT-IR spectrum of Washed soil sample

(Source: CLIF, karyavattom)

The above figure shows the FT-IR analysis of washed soil. In the above graph there is no peak identified between the regions 2800cm^{-1} -3600cm^{-1}, which marks the absence of saturated compounds, hydrocarbons and other contaminants. This may be accounted with the presence of more number of binding sites for carboxylic acid group on Saponin. This indicates that Saponin could remove the contaminants and saturated oily compounds from the soil to some extent. This highlights the surfactant property of Saponin for various contaminants.

4. CONCLUSION

In this study the effect of a natural surfactant on elimination of saturated oily compounds from a Used Motor Oil contaminated soil was investigated. Saponin is used as the surfactant for removing oil from soil by the method of soil washing. The FT-IR analysis of the soil samples were conducted for assessing the performance of Saponin in removing the contaminants from soil. The region lying between 2800cm^{-1} -2000cm^{-1} shows the presence of contaminants. The FT-IR spectrum of contaminated soil has peaks formed in this region indicating the presence of saturated oily compounds as contaminants. The spectrum of washed soil had no major peaks in the region between 2800cm^{-1} -2000cm^{-1}. This shows that washing with Saponin can remove contaminants in the form of saturated oily compounds from soil.

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