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Study on Effect of NPK Fertilizer and Cow Dung on Oil Contaminated Soil

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Abstract: Soil contamination with oil spills is a serious threat these days. Remediation to this situation can be done by both chemical and biological methods. This project deals with the remediation of oil contaminated soil with NPK fertilizer and dried cow dung. The purpose of the present study was to evaluate and compare the biodegradation performance of the application of animal manure and inorganic chemical fertilizer, respectively, in the bioremediation of soil contaminated with petroleum hydrocarbon mixtures (kerosene, diesel oil, and gasoline mixtures).
Keywords: Contamination, biodegradation, animal manure, inorganic chemical fertilizer, remediation

I. INTRODUCTION

Soil contaminated with petroleum product have serious hazard to human health. It also contaminates ground water and decreases agricultural productivity. As a result of crude oil pollution, soil physical properties such as pore spaces might be clogged which reduces soil aeration, infiltration of water into the soil, increased bulk density of the soil which may affect plant growth. Crude oil can restrict permeability. All these possibilities deserve empirical studies to establish their reality or otherwise. Therefore, this particular study had its main objective to examine the effects of crude oil pollution on soil physical properties.

II. MATERIALS AND METHODOLOGY

The addition of NPK fertilizer and dried cow dung can be used for the remediation of contaminated soil. For the project experimental study, we collected 110 kg of soil. From which 10kg was taken to determine the physical properties of the soil. This was taken as reference soil and assumed that the soil is free from oil contamination. The rest 100kg soil was divided into two equal parts (50kg) and each 50kg soil was contaminated with petrol, diesel, and kerosene in the proportions 5:3:2. From the proportion, we had taken a 10kg sample to find the properties of artificially contaminated soil.

The rest of the contaminated soil was again divided into two that is, 5:3:2 contaminated soil of 40kg was divided into 2 equal parts of 20 kg. Then to 20kg sample of 5:3:2 we added cow dung (4kg) as decontaminant. The rest 20kg of 5:3:2 was decontaminated with NPK (3.5kg). After adding the decontaminant (NPK and cow dung) the artificially contaminated soil was submitted to curing for 4 weeks. Properties of decontaminated soil at each week were determined and values were recorded.

III. EXPERIMENTAL PROCEDURES:

The tested properties and their experimental set up are as follows:

A. Atterberg's Limits:

1) Determination of Liquid Limit is as Follows

a) Specific gravity of soil particles can be determined by using IS 2720-5 (1985) by the following procedure.

b) Place about 250g of air dry soil passing through 425micron sieve in an evaporating dish and mix it thoroughly with water to form a uniform smooth paste.

c) Place a portion of the paste in the cup of the liquid limit device shown in the Fig 4.2, smoothen the surface off to a maximum depth of 10mm.

d) Draw the grooving tool through the sample along the symmetrical axis of the cup in one stroke, holding the tool perpendicular to the cup at the point of contact.

e) Turn the crank in uniform speed of 2 revolutions per second and count the blows necessary to close the groove in the soil for a distance of 12mm.

f) The groove should be closed by a flow of the soil and not by slippage between the soil and the cup.

g) By adding sufficient water, obtain the number of blows between 15 and 35. When a value in the range of 15 to 35 blows is obtained, take approximately 10g of soil from near the closed grooved for water content determination.
h) A minimum of such 4 readings are taken.
i) Make a plot of water content against no. of blows in a semi log graph. Such a plot known as flow curve and is usually a straight line.
j) From the graph obtain the water content corresponding to 25 numbers of blows as the liquid limit of soil. Also obtain the value of flow index which is the slope of flow curve.

2) *Determination of Plastic Limit is as Follows:* Place about 30g of the thoroughly mixed air dry soil passing through 425 micron sieve in an evaporating dish and mix it with sufficient quantity of distilled water until the mass becomes plastic enough to be easily rolled into a ball. Take about 30g of the ball and roll it on a glass plate with the hand to form the soil mass into a thread of uniform diameter of 3mm throughout its length. The rate of rolling shall be between 60 and 90 strokes per minute. Knead the soil together and again roll in the form of a ball. Repeat step 2 until a 3mm diameter thread shows signs of crumbling. Take pieces of the crumbled material for water content determination. Report this water content to the nearest whole number as plastic limit.

B. Determination of pH

pH of soil particles can be determined by using IS 3025 Part 11 (1980) by the following procedure. The pH meter was calibrated using pH 7 buffer solution. Then the meter was adjusted with known pH of buffer solutions 4.0 and 9.2. 20 g of soil was weighed and transferred into 100 mL beaker. 40 mL distilled water was added and stirred well with a glass rod. This was allowed to stand for half an hour with intermittent stirring. To the soil water suspension in the beaker, the electrode was immersed and pH value was determined from the automatic display of the pH meter. The experiment apparatus are shown in the figure.

1) *Determination of Specific Gravity of Soil:* The specific gravity of soil particles is the ratio of the unit weight of the soil solids to that of water. Specific gravity of soil particles can be determined by using IS 2720-3 (1980) by the following procedure.
a) Clean, dry and weight the pyconometer (shown in Fig 4.5) accurately (W1).
b) Take about 200 gram of oven dry soil sample in the pyconometer and weight again. (W2)
c) Add distilled water in the pyconometer and stir it to remove entrapped air.
d) Fill the pyconometer to flush with marked line / hole in the conical cap and weight it. (W3)
e) Empty the pyconometer and clean it. Fill the pyconometer with distilled water up to marked line / top of the cap and weight it. (W4)
f) Repeat the test at least twice more.

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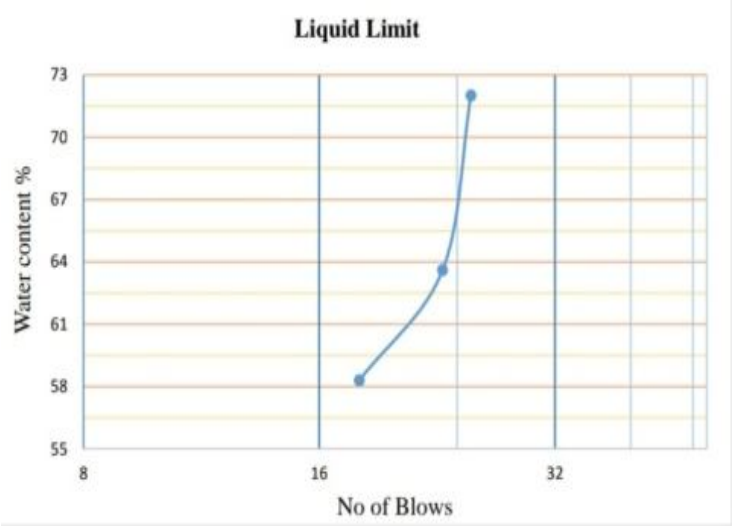
IV. MATERIALS USED

The materials used for the study of the project are discussed below.

A. Laterite Soil

The soil used in this project is laterite soil. This soil is collected from Ernakulam. The properties and graphs showing the properties of soil are given in the table below

Soil Classification	Value Obtained
Specific Gravity of Soil	2.67
Liquid Limit of Soil (%)	63
Flow Index	48.8
Plastic Limit (%)	43.33
Plasticity Index	20.33
Toughness Index	1.295
Ph	6.83



From the flow curve the water content corresponding to 25 no. of blows i.e., liquid limit is obtained as 63%.

B. NPK Fertilizer

The inorganic fertilizer (NPK; 15-15-15) which is composed of nitrogen, phosphorus and potassium

C. Dried Cow dung

The cow dung was sun dried for three week and was powdered. This powdered cow dung was passed through a 4.75 mm standard mesh sieve thereafter.

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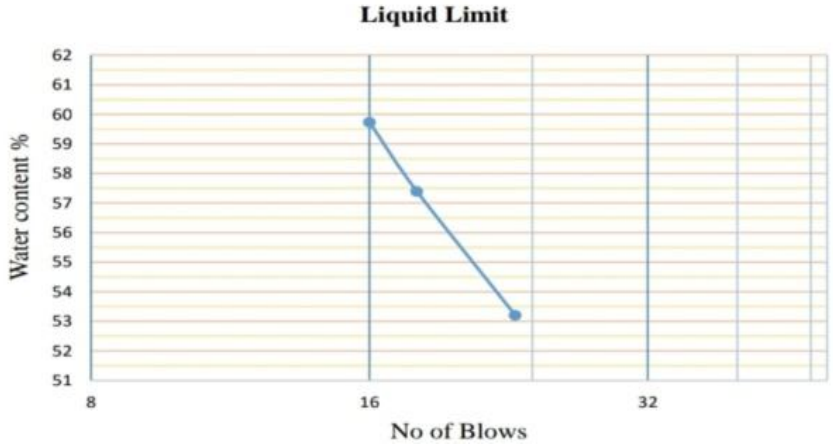
V. RESULTS AND DISCUSSIONS

After contaminating the soil with petroleum products various physical and chemical properties where determined. The results are given below.

A. Effect Of Petrol, Diesel And Kerosene In Ordinary SOI

The properties and graphs of soil with this proportion of contamination level is given in the table below

Soil Classification	Value Obtained
Specific Gravity of Soil	2.107
Liquid Limit of Soil (%)	54
Flow Index	36.37
Plastic Limit (%)	28.9
Plasticity Index	25.1
Toughness Index	0.618
pH	5.69



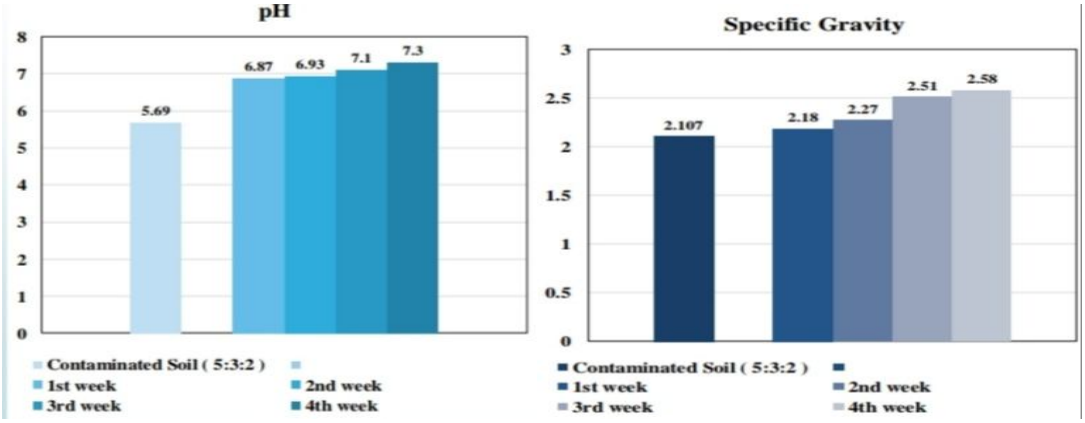
From the flow curve the water content corresponding to 25 no. of blows i.e., liquid limit is obtained as 54%.

B. Effect Of NPK Fertilizer On Oil Contaminated SOIL

Comparison of variation in properties of ordinary soil after contamination and remediation.

Soil Properties	Ordinary soil (C)	Oil contaminated soil (P1)	Remediated soil after 4^{th} week (NPK)
Specific Gravity of Soil	2.67	2.098	2.58
Liquid Limit of Soil (%)	63	54	62
Flow Index	48.8	36.37	44.21
Plastic Limit (%)	43.33	28.9	36.19
Plasticity Index	20.33	25.1	25.81
Toughness Index	1.295	0.6	1.27
pH	6.83	5.69	7.3

The properties and graphs of soil contamination level treated with NPK fertilizer is given below

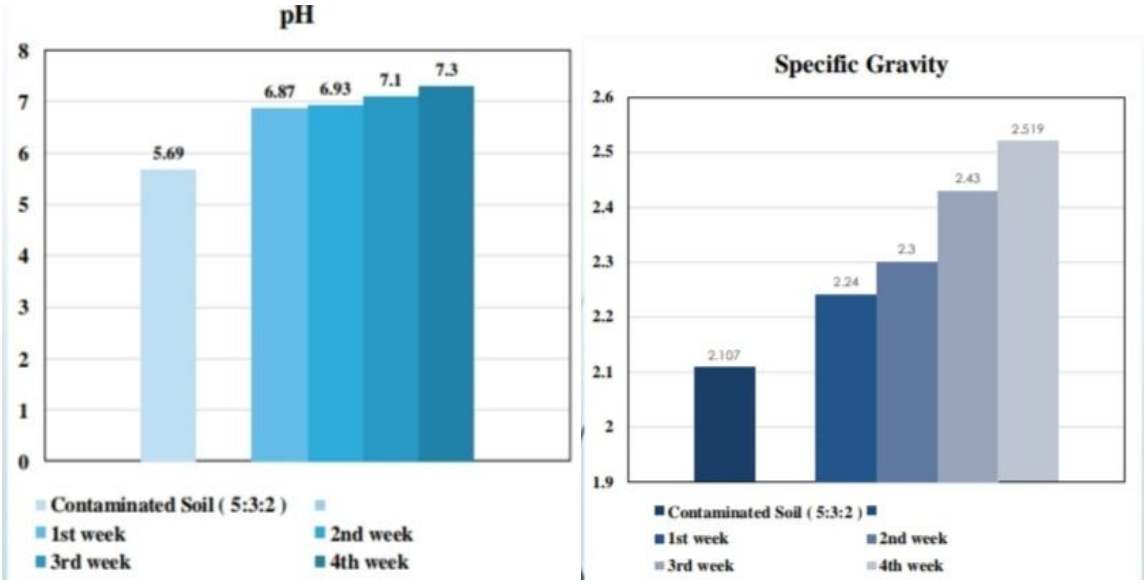


From above figures, it indicates that the soil after 4 weeks with addition of NPK fertilizer has significantly regained its original properties.

C. Effect Of Dried Cowdung On Oil Contaminated SOIL

Comparison of variation in properties of ordinary soil after contamination and remediation given below

Soil Properties	Ordinary soil (C)	Oil contaminated soil	Remediated soil after 4^{th} week(CD)
Specific Gravity of Soil	2.67	2.107	2.519
Liquid Limit of Soil (%)	63	54	60
Flow Index	48.8	36.37	40.56
Plastic Limit (%)	43.33	28.9	35.86
Plasticity Index	20.33	25.1	26.21
Toughness Index	1.295	0.618	1.26
pH	6.83	5.69	7.19



VI. CONCLUSION

The results indicated that the applied animal manure and chemical fertilizer increased the degradation of the petroleum hydrocarbons. Thus, all the bio stimulating treatment strategies showed the ability to enhance petroleum hydrocarbon microbial degradation. However, treatment with cow dung showed greater petroleum hydrocarbon reductions than NPK fertilizer treatment. This may possibly be due to the addition of higher nutrient level and hydrocarbon-utilizing bacterial species in poultry, piggery, and goat manure soil treatments than in chemical fertilizer (NPK) soil treatment. pH of soil increased thus showing less acidic property and in turn improving the productivity of soil. Also considerable improvement in soil permeability was noted after 4 weeks of remediation. It is economical when compared with other conventional measures.

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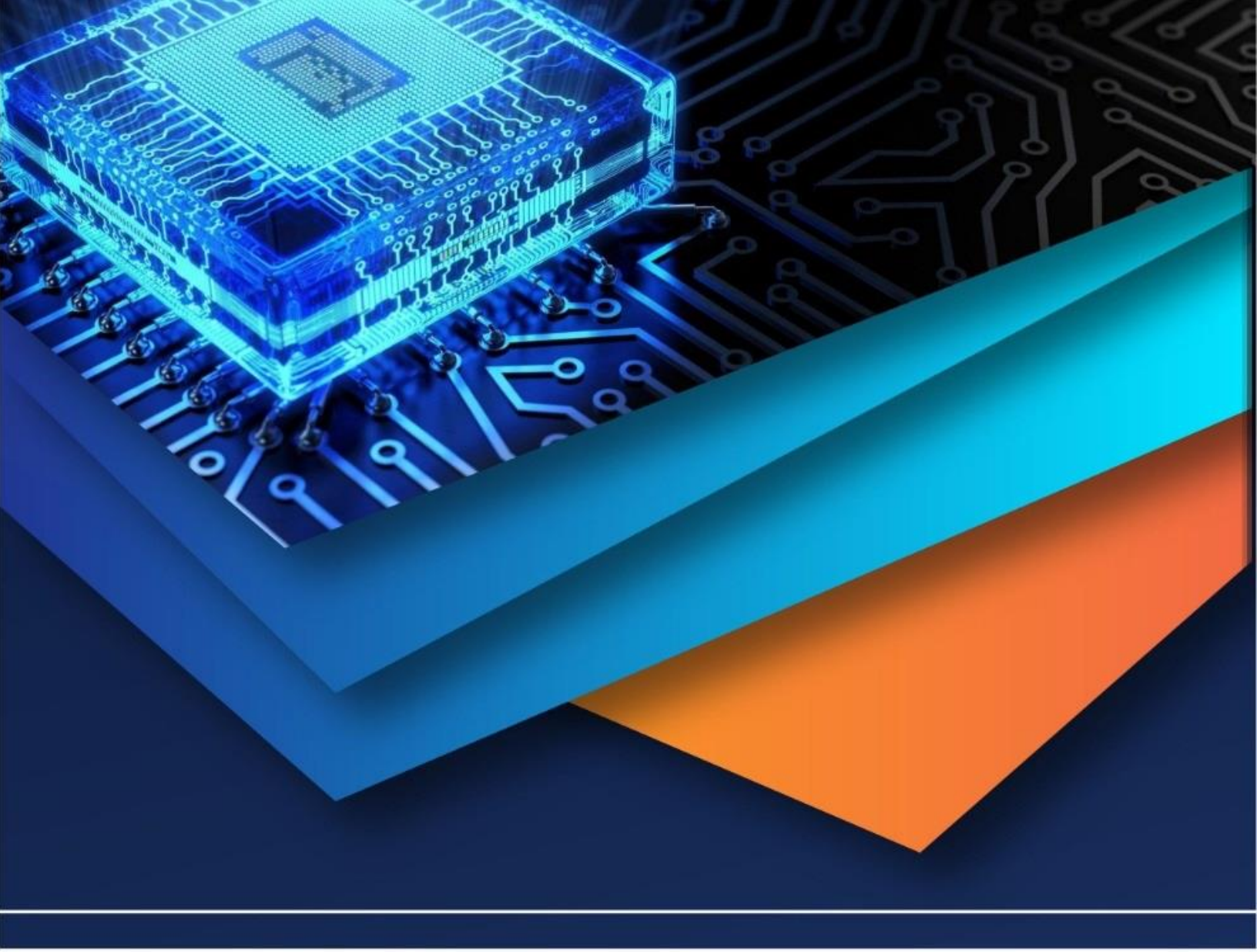

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