International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 6 Issue 03, March-2017

Comparative Study on Remediation Techniques for Petroleum Contaminated Soil

Resmi Ramesh Kumar
M-Tech Student
Department of Civil Engineering
St. Thomas Institute for science and Technology
Trivandrum, India

Nisha Roy N.P
Assistant Professor
Department of Civil Engineering
St. Thomas Institute for Science and Technology
Trivandrum, India

***Abstract*— Soil contamination due to crude oil has been recorded as a widespread environmental problem due to their adverse effect on ecosystem. The TPH (Total Petroleum Hydrocarbon) concentration in soil near refineries, has been recovered through many techniques. This project shows the result of an experimental investigation evaluating the treatment condition of Fenton's Oxidation process and phytoremediation technique to study the TPH removal efficiency in petroleum contaminated soil.**

Keywords*— Petroleum contaminated soil, TPH (Total Petroleum Hydrocarbon), Fenton's Oxidation, Phytoremediation.

I. INTRODUCTION

Soil contamination is becoming a widespread environmental problem of major concern. Petroleum compounds are one of the most frequently encountered pollutants in soil adjacent to oil refineries. The presence of petroleum hydrocarbons in soil is not only an adverse factor for human health, but also an negative impact on plant growth and development. Enormous effort has been made to find efficient and effective ways to remediate petroleum contamination in soil. Chemical and biological methods have shown to oxidise and degrade organics which not only destroy the target compounds but also reduce toxicity. In this study, Fenton's reagent is used for the chemical oxidation process and plants like barley and sorghum are selected for phytoremediation. The TPH concentration of both the remedial techniques are evaluated using Gas Chromatograhy and a comparative study of the TPH removal efficiency of both the techniques are studied.

.

A. Objective of the Study

- To determine the physical and chemical properties of contaminated soil.
- To evaluate the optimal treatment condition of Fenton oxidation process to remove hydrocarbons in contaminated soil at various pH levels of reagent.
- To evaluate the TPH concentration of contaminated soil after phytoremediation technique.
- To conduct a comparative study on the removal efficiency on TPH by chemical oxidation and phytoremediation technique.

II MATERIALS AND METHODOLOGY

A.MATERIALS

1) Soil:

The contaminated soil sample necessary for the thesis work was collected from Hindustan Petroleum Co.Ltd, Irumpanam, Ernakulam. "Fig.1" shows the soil sample.

Fig.1 Petroleum Contaminated soil

'Table.I' shows the physical properties of the contaminated soil

Table. I: Physical properties of soil sample

Sl.No:	Properties	Values
1	Specific Gravity	2.6
2	Water Content(%)	17
3	Plastic Limit (%)	28.12
4	Liquid Limit (%)	32
5	Sand (%)	43
6	Silt (%)	26
7	Clay (%)	31

'Table.II' shows the Chemical properties of the contaminated soil.

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 6 Issue 03, March-2017

Table. II: Chemical properties of soil sample

Sl.No:	Properties	Values
1	pH	4.7
2	Organic Matter (%)	4.17
3	Total Nitrogen (mg/kg)	1532
4	Phosphorous (mg/kg)	31
5	Pottassium (mg/kg)	49
6	CEC (cmol/kg)	5.3

2) Chemical:

The chemical used for chemical analysis is Fenton's Reagent, which is a solution of Hydrogen Peroxide and Ferric iron as catalyst used to oxidize the contaminants. 'Table.III' shows the properties of Reagent used.

Table. III : Properties of Reagent

Sl.No:	Properties	Values
1	Chemical name	Fenton's Reagent
2	Appearance	Yellow-Orange solution
3	Molecular Formula	$FeH_4O_6S^{2+}$
4	Molecular weight	186.821 g/mol
5	Exact mass	186.709 mol

3)Plants:

Phytoremediation was performed on Barley and Sorghum seeds, kept under observation for TPH determination for 30 days.

B. METHODOLOGY

The initial TPH concentration of contaminated soil was determined and the remediation techniques of chemical analysis and phytoremediation are implemented.

1) Chemical Analysis:

In chemical analysis, Fenton's Reagent is used for remediation with different molar ratios of H_2O_2 and Fe^{3+} each at various pH levels. 10g of soil was added by 20 ml of distilled water with reagent of desired pH levels, mixed in a centrifuge tube kept under observation for 24 hrs. The supernatant liquid was removed and the soil was extracted by toluene and TPH concentration was determined using Gas Chromatography.

2) Phytoremediation

Barley and Sorghum seeds are used. 30 days after sowing, the soil samples were collected from the rhizosphere and non-rhizosphere zones to determine the TPH concentration .

III. RESULTS AND DISCUSSIONS

After the determination of the basic physical and chemical characteristics, the soil was subjected to chemical analysis and phytoremediation for remedial measures and a comparitive study was conducted for the same.

A) Results of TPH removal efficiency at 50:1 molar ratio of Fenton's Reagent

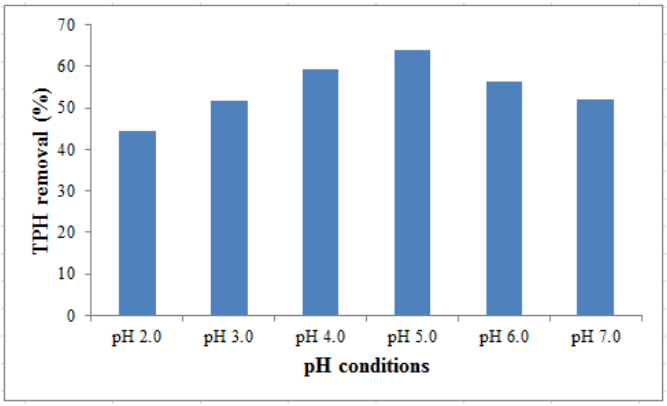

Fig.2 pH condition on TPH mass removal at 50:1 of reagent

'Fig.2' shows the effect of pH condition on TPH removal at 50:1 molar ratio of reagent. The pH condition test showed a maximum TPH removal efficiency of 63.77% at pH of 5 at 50:1 molar ratio of Fenton's Reagent.

B) Results of TPH removal efficiency at 100:1 molar ratio of Fenton's Reagent

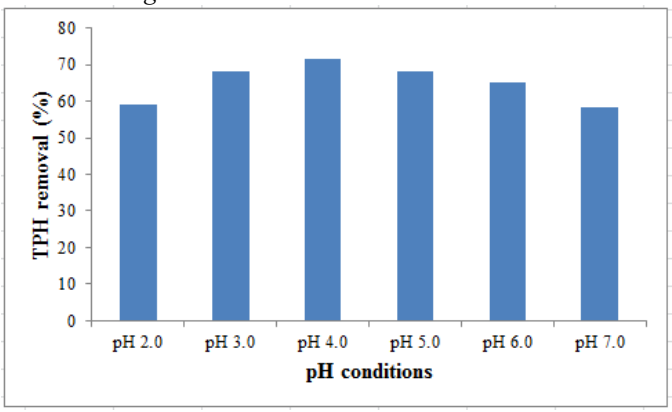

Fig.3 pH condition on TPH mass removal at 100:1 of reagent

'Fig.3' shows the effect of pH condition on TPH removal at 100:1 molar ratio of reagent. The pH condition test showed a maximum TPH removal efficiency of 71.72% at pH of 4 at 100:1 molar ratio of Fenton's Reagent.

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 6 Issue 03, March-2017

C) Results of TPH removal efficiency at 200:1 molar ratio of Fenton's Reagent

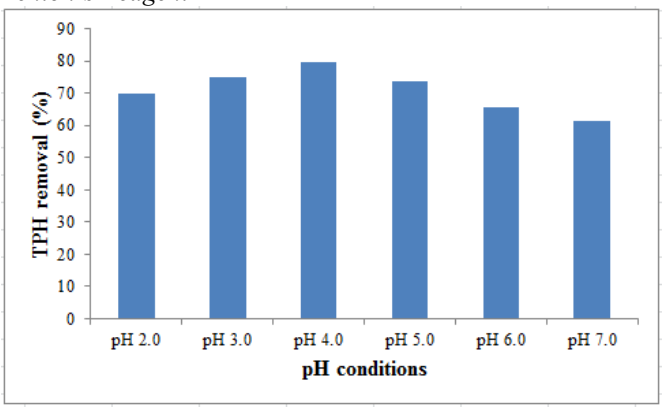

Fig.4 pH condition on TPH mass removal at 200:1 of reagent

'Fig.4' shows the effect of pH condition on TPH removal at 200:1 molar ratio of reagent., The pH condition test showed a maximum TPH removal efficiency of 79.81% at pH of 4 at 200:1 molar ratio of Fenton's Reagent.

D) Results of TPH removal efficiency at 300:1 molar ratio of Fenton's Reagent

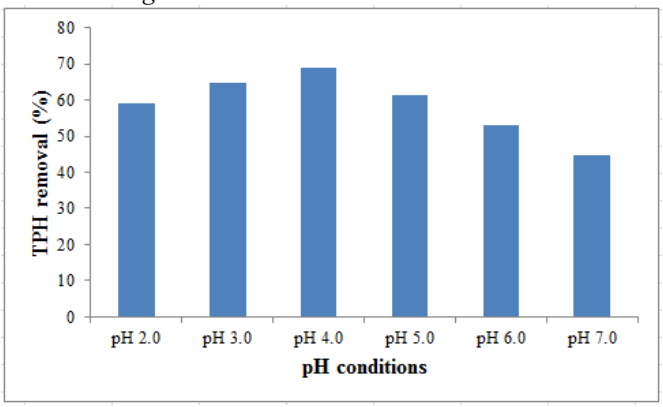

Fig.5 pH condition on TPH mass removal at 300:1 of reagent

'Fig.4' shows the effect of pH condition on TPH removal at 300:1 molar ratio of reagent., The pH condition test showed a maximum TPH removal efficiency of 68.77% at pH of 4 at 300:1 molar ratio of Fenton's Reagent.

E) Results of TPH removal efficiency by Phytoremediation.

The effect of plant species such as barley and sorghum in eliminating the TPH concentration on contaminated soil was evaluated.

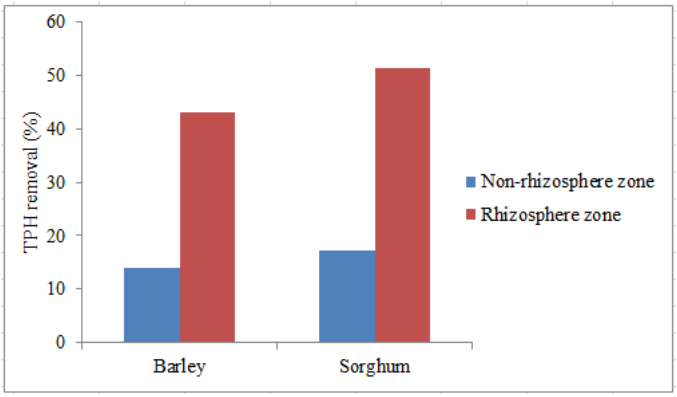

Fig.5 Graph showing the removal efficiency of Barley and Sorghum in Phytoremediation

From 'Fig.5' the results show that sorghum is more effective in eliminating the TPH concentration in contaminated soil than barley with a removal efficiency of 51.27%.

IV. CONCLUSION

A decrease of TPH concentration was found over the course of experiment in all treatments. The result of chemical analysis using Fenton's oxidation process demonstrated that there was a removal efficiency of 79.81% at 200:1 molar ratio with pH of 4. Phytoremediation showed a decontamination of 51.27%. Also, the soil in the rhizosphere zone of the plant species was found more effective in eliminating the TPH than the soil in the non-rhizosphere zone. Comparing the two decontamination techniques, chemical analysis was proved to be more than phytoremediation.

ACKNOWLEDGMENT

I would like to express my sincere gratitude to my guide, *Mrs. Nisha Roy N.P*, Assistant Professor, Department of Civil Engineering, STIST for her valuable guidance, motivation and constant inspiration and above all for her ever co-operating attitude that enabled me in bringing up this thesis in the present form. I am thankful to her for the encouragement she has given me in completing this thesis. I would also like to thank the staffs of SCT Institute of Biotechnology, Poojappura, Trivandrum and CEPC Kollam for their immense help and support in completing my thesis. I am also greatly thankful to all the staff members of the department in STIST and all my well-wishers and friends for their inspiration and help.

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 6 Issue 03, March-2017

REFERENCE

[1] Brian Kamnikar, P.E. "Managing petroleum contaminated soil: Department of Transportation Perspective" *International Journal of Geotechnical Engineering* Vol. 127, No. 12, December, 2001.

[2] P.Xu, G.Achari, M.Mahmoud and R.C Joshi; "Application of Fenton's Reagent to Remediate Petrol Contaminated Soils", ASCE, 2006.

[3] Etsuko Kaimi, Tsukasa Mukaidani and Masahiko Tamaki; "Screening of Twelve Plant Species for Phytoremediation ofPetroleum Hydrocarbon-Contaminated Soil", *Plant Production Science Vol.10, 2007.*

[4] Ali Daryabeigi ZAND, Gholamreza Nabi BIDHEND, Nasser MehrdadiI; "Phytoremediation of total petroleum hydrocarbons (TPHs) using plant species in Iran**"** *Department of Environmental Pollution, Environmental Sciences Research Institute: 2009*

[5] M. Lu, Z. Zhang, W.Qiao, Y.Guanb, M. Xiao, and C.Peng, "Removal of residual contaminants in petroleum-contaminated soil by Fenton-like oxidation" *Journal of Hazardous Materials*, vol. 179, pp. 604-611, Mar. 2010

[6] L.Ershadi, T.Ebadi, A.R Rabbani; "Chemical Oxidation of Crude Oil in Oil Contaminated soil", 2011 *2nd International Conference on Environmental Science and Technology* IPCBEE Vol.6 (2011).

[7] C.Pongcharoen, K.Kaiyavogand, T.Satapanajaru; "Remediation of Petroleum Hydrocarbon – Contaminated Soil Slurry by Fenton Oxidation*", International Journal of Geotechnical, Environmental and Geophysical Engineering.* Vol:6, No:9, 2012.