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Physico-Chemical Characteristic of a Petroleum Contaminated Soil from the Spill site of Jaffna District.

V.P.S.Richardson[1*], G.B.B.Herath[1,] C.S.Kalpage[2], K.B.S.N.Jinadasa[1]

[1]Department of Civil Engineering, University of Peradeniya.
[2]Department of Chemical and Process Engineering, University of Peradeniya.
*E-Mail: stevenprassanna@gmail.com

Absrtact: Contamination of soil with petroleum products is among the most common sources of pollution in an industrialized world. This poses severe threats to the local communities and the ecosystem. Consequences of soil contaminations by petroleum products are multi-dimensional and thus their assessment has remained major problem. The presence of total organic carbon (TOC), heavy metals, electrical conductivity (EC) and pH were determined from petroleum contaminated soil samples from the spilled location of power plant premises of Chunnakam, Jaffna district. Three spilled locations have been identified and samples were collected from each location for this study. Control samples were collected from the uncontaminated location from the area same as the geology of the affected area. Results revealed that the heavy metal content of lead and nickel were higher than those of the control site and the recommended permissible limit. Evidence of severe hydrocarbon contamination was confirmed by presence of elevated level total organic carbon in the contaminated soil. Other analyzed metals including ferrous and manganese and physical parameters such as electrical conductivity and pH in the impacted zone have not shown any significant differences, while compared to the control samples.

.**Keywords:** Heavy Metals, Total organic carbon, Oil Spills, Soil Contamination.

1. Introduction

Past power plant activities in the area of power plant premises of Chunnakam, have resulted in heavily polluted soils. Plant effluents and oily wastes had been disposed to the nearby land plots over to several years without any mandatory regulations being followed. Contamination of soil by petroleum products is a severe environmental problem. This contaminated soil could poses a constant threat to local communities, due to the possibility of pollution spreading to the surrounding areas (Radu and Diamond,2009).Remediation of soil compared to water and air is difficult, due to the complexity of assessment of overall toxicity (Rank and Lawrence, 2013) and complex spatial distribution of the contaminant in the subsurface.

Refined petroleum products are complex mixtures of variety of hydrocarbons, heavy metals, antioxidants, corrosion inhibitors and other additives (Callot and Ocampo, 2009; Essien and John, 2010). Heavy metals in the refined petroleum product may have resulte

from the natural occurrences and resultants of

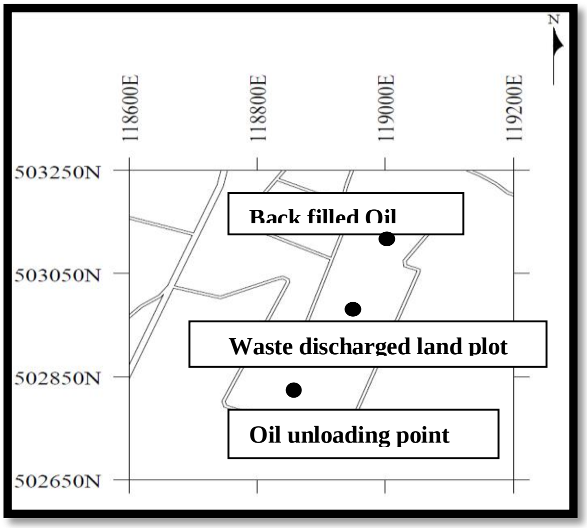

Figure 1: Soil sampling locations in side the power plant premises

the cracking process of crude oil. These pollutants may persist for a long time in the environment and act as a continuous source of hazardous compounds to the soil and as well as the groundwater (Ostendorff, 1990; Essaid et al., 1995). Marwood et al., (1998); Kelly and Tate (1998) and Amadi et al., (1996) measured the heavy metal concentration to quantify the degree of contamination in soil matrix There are several evidences, but are not limited to, (Coyne, 1999; Kelly and Tate, 1998; Amadi et al., 1996) that the soil ecosystem could significantly loss in quality due to the impact of petroleum hydrocarbons. Testa, 1997 observed diminished microbial biomass and microbial activities in contaminated soil profile due to the toxicity of petroleum hydrocarbons. Muniz et al., 2004 discussed the seriousness of contaminant accumulation in organisms through the food chain, due to the contaminants uptake by plants.

Similar to the inorganic constituents, soil consist of natural organic matters which derived from decaying animal and plant residues and from soil biomass. Several anthropogenic activities also contribute to the soil organic matter. As petroleum hydrocarbons consist of the vast diversity of complex organic carbon compounds, oil contamination substantially increase organic carbon level in the soil matrix. Therefore, determination of the amount of organic carbon may have helpful to delineate the contaminated soil from the uncontaminated zone.

The main objective of this study is systematic comparison of the soil matrix in the vicinity of the Power Plant Premises and at a control site. This may facilitate to delineate the contaminated soil zone from the uncontaminated zone and helpful in the estimation of the magnitude and the level of contamination. The specific task of this phase is intended to quantify the degree of contamination of soil matrix on the basis of heavy metal and total organic carbon presence.

2. Material and Methods

2. 1 Soil Sampling and Preservation

Top soil samples were collected from the three identified spilled locations within the Power Plant Premises. Individual soil samples were put in labeled polythene bags and flame sealed. Sealed samples were stored in a cooler box until brought to the laboratory. Samples were stored in the laboratory at 4^0C in a refrigerator until analyses were made.

2. 2 Preparation of soil samples

Samples were individually air dried at room temperature and sieved with the 2 mm sieves. Sieved samples were checked through the hand lens and remaining plant debris and calcium carbonate particles taken by autoclaved forceps

2.3 Analysis for heavy metal and other metals

Individual soil sample were weighed (250 mg) and transferred to digester vessels for soil digestion process. The samples were left in contact with the acid solution overnight and digested using a microwave assisted reactor system. Digested soil samples were filtered and analyze for ferrous, lead, manganese and nickel with the atomic absorption spectrophotometer.

2. 4 Analysis for total organic carbon

Analysis of the organic carbon by dry combustion method was performed by organic elemental analyzer (Flash 2000 Organic elemental analyzer). 50mg of individual soil sample were weighed in a clean ceramic blocks and allowed to react with fresh concentrated hydrochloric acid in order to remove any inorganic carbon. Reacted samples were heated in the oven for one hour at 60 ^{0}C to drive off residual acid. 15mg of treated soil samples were wrapped in tin capsules and capsules introduced to the analyzer.

2. 5 pH and Electric conductivity

Soil samples were weighed (2 g) and transferred to a Teflon (PTFE) bottle. Distilled water was added (10 ml) into each bottle with soil, and the bottles were placed on a shaker, and were mixed for 4 hours. Then, the solutions were filtered through Watchman 42 filter papers and solutions were measured for pH and electrical conductivity by pH meter and electrical conductivity meter.

3. Results and Discussion

Table 1: Heavy metal content and total organic carbon content for all soil samples collected from three contaminated sites and the reference site are presented in Table. Electrical conductivity and pH of the samples are also presented

Location	pH	EC µS/cm	TOC (w/w%)	Pb (ppm)	Ni (ppm)	Fe (ppm)	Mn (ppm)
Back filled oil lake	7.82	127	1.66	5-6	13.5-14	164	82
Oil unloading point	8.5	190	2.09	2-2.5	4-4.5	162	46
Waste discharged plot	7.42	100	16.23	8-8.5	24-25	162	61.5
Control site	7.61	111	0.54	1-2	0.5-1	157	52.1

Heavy metals lead and nickel in the soil samples from the contaminated zones were compared with the uncontaminated zone. The results clearly demonstrate that concentration levels substantially increased at the suspected contaminated sites. These observations with respect to heavy metal (Pb, Ni, Cu and Zn) were consistent with the reported results by Abdhullah et al. (1972), Scerbo et al. (2001), Figueira et al. (2002) and Fatoba et al. (2013**)**. No remarkable changes were observed in ferrous and manganese contents at the contaminated sites compared to the reference zone.

Soil samples from the location waste discharged point showed substantially higher level of organic carbon. The TOC content of the zone is 30 times higher than the uncontaminated reference zone. This elevated levels of TOC values than the uncontaminated reference zone, could be attributed to the heavy impact from organic compounds from the petroleum wastes and oily effluents (Ellis and Adams, 1961;Coker and Ekundayo, 1994). Other two locations also showed elevated level of TOC values compared to the control sample. Electric conductivity and pH associated with most of the soil samples has not been shown significant difference in comparison with the control samples.

4. Conclusion

It can be concluded that the evidences of severe contamination of the soil profile by petroleum contaminants of the impacted sites compared to the un-impacted site on basis of total organic carbon presence. Results of the heavy metal analysis obtained from the soil samples also confirm high soil pollution from heavy metals in the area. High concentration of these pollutants could be very hazardous to human health and as well as the living organisms, when too much level of pollutants are biologically accumulated through the water sources or by food chain.

5. Recommendations

Having successfully analyzed the soil samples from the plant premises, it has confirmed that the soil was polluted. Hence, it is pertinent, that adequate remediation and complete cleanup measures should be carried out on the sites to save the environment as soon as possible.

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