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A Study on the Effect of Chemical Remediation and Phytoremediation on Soils Contaminated by Hospital Waste, Chemical Fertilizers and Slurry Waste

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***Abstract* – Soil contamination has now become one of the major concerns over the past few decades. It has increased the concern over help and ecological imbalance, which has lead to the need for cost-effective remediation techniques for soil contamination. The use of plants and introduction chemical oxidants to contaminated soils are found to be extremely effective degrading several types of contaminants including polyaromatic hydrocarbon (PAH), high organic contents, metal concentrations, chlorinated compounds, polyvinyl chloride (PVC) and others. This paper deals with studying three types of contaminated soils, viz; Hospital waste contaminated soils, chemical fertilizer contaminated soil and slurry waste contaminated soils and their remediation techniques using chemical reagents including Condy's crystals and sodium Hydroxide and phytoremediation using Arrowroot plants. It was found that chemical reagents are more effective than phytoremediation in concern with contaminant reduction and time. Remediation using Condy's crystals gave best effective results than with other two remediation techniques for the differently contaminated soils.**

Keywords*— *Condy's crystals, phytoremediation, chemical reagents, contaminants,chmical fertilizers, slurry

I. INTRODUCTION

Soil contamination is defined as the changes in the soil properties due to the accumulation and build-up in soils of harmful substances including toxic compounds, chemicals, disease causing agents, salts, radioactive materials, pharmaceutical leftovers which cause adverse effect on the plant and animal lives. Soil pollution can retard the plant growth, cause health issues to the animals and affect the useful microorganisms present in the soil. The sources of soil pollution include wastes from industries, household areas, hospitals, kitchen wastes, ,nuclear plants and fertilizer using agricultural areas and so on.

The wastes from hospitals, agricultural areas, and household activities are the commonly met soil contaminants. Thus there arise a need to study about the soil contamination due to above mentioned wastes and to implement cost-effective remediation techniques, which gain commercial acceptance. Chemical analysis of the contaminated soils indicated that organic compounds ,polyaromatic hydrocarbons (PAH),Polyvinyl chloride (PVC),chlorinated compounds, metals, pharmaceutical leftovers were present in the three samples containing hospital waste, chemical fertilizers and slurry waste taken for the analysis.

Since the amount of contaminants is more the remediation has to be done to these soils, that too in a cost effective way. Here both chemical remediation and phytoremediation techniques are used for the study. Condy's crystals and Sodium hydroxide were used as the chemical reagents for the study. Condy's crystals are promising when the contaminants are amenable to their mineralization to water and Carbon dioxide or oxidation to a less harmful product, which enables subsequent treatment. The relative oxidation power of Permanganate ion is 1.24. it when reacts with organic compound produce Manganese dioxide and Carbon dioxide. Sodium hydroxide is useful in degrading metal concentration present in the soil and other organic compounds. Phytoremdiation is done to the soil for a period of 3.5 months. Arrowroot plant is used for the purpose of study.

In this study an attempt is made to determine the efficiency of three remediation techniques in degrading the contaminants of three different soils contaminated with hospital waste, chemical fertilizer and slurry waste.

II. OBJECTIVE OF THE STUDY

- To determine the amount and type of contaminants present in the three types of soils.
- To perform suitable remediation techniques for the contaminated soils.
- To find out the most efficient method of remediation among the three methods.

III. MATERIALS AND METHODS

A. Materials

Both contaminated and uncontaminated soil samples of each type were collected purpose of study. All three samples were collected from a depth of 0.5m at spacing of 0.5m from their respective sites and mixed thoroughly to get a uniform mix.

Soil sample 1: Soil samples were collected from an area where the wastes from a Multispecialty hospital at Trivandrum area are dumped in heaps before it goes into the

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treatment plant. The contaminated samples were collected as mentioned above. Uncontaminated samples were collected from a distance of 3 km away from the contaminated site from a depth of 0.5m at a spacing of 0.5m

Soil sample 2: Soil samples were collected from an area where excessive amount of chemical fertilizers are used for agricultural purpose at Pallickal, Trivandrum. The soil here is polluted with high doses of fertilizers. The fertilizer used in this type of soil is FACTOMFOS (Ammonium Phosphate Sulphate). Sample collection was carried out according to the above mentioned way. Uncontaminated samples were collected from a distance of 1km away from the contaminated site at a depth of 0.5m at a spacing of 0.5m. Table 1 shows the chemical composition of the fertilizer.

TABLE1. CHEMICAL COMPOSITION OF FERTILIZER

MINERAL	AMOUNT (%)
Nitrogen	20
Phosphorous	20
Sulphur	13
Ammonium Phosphate	40
Ammonium Sulphate	60

Soil sample 3: The slurry waste contaminated soil samples were collected from a housing colony sharing same biogas plant at Pallickal, Trivandrum. All types of kitchen wastes and garbages excluding plastics and shells, goes into the plant. The organic content of such soils will be very high. Samples were collected according to the above mentioned way. Uncontaminated samples were collected from a distance of 1 km away from the contaminated site from a depth of 0.5m at a spacing of 0.5m. Table 2 shows the properties of slurry that contaminates the soil. 50ml of slurry was collected for 7days and mixed to get a uniform fluid.

TABLE 2. PROPERTIES OF SLURRY

PROPERTY	VALUE
pH	7.4
Solids (%)	12
Ammonia (g/l)	0.9
Nitrogen (g/l)	3
Phosphorous (g/l)	2.75
Volatile acids (g/l)	5.25
BOD (g/l)	1200

B. Properties of the representative soil samples

pH of the selected soil samples, both contaminated and uncontaminated soils were determined by standard methods. Specific gravity of the three soil samples were determined according to IS: 2720(part 3 Bureau of Indian standards 1980 a). Atterberg limits of the representative soil samples were found out according to IS 2720 part 5, (Bureau of Indian standards1985 b) and IS 2720 (part 6 Bureau of Indian standards 1972). Particle size distributions of soil samples were determined according to IS2720 (part 4 Bureau of Indian standards 1985a). The standard proctor compaction test was done according to IS 2720(part 7 Bureau of Indian standards 1980b). Table 3, Table 4, Table 5, shows the properties of both contaminated and uncontaminated samples.

TABLE 3.INDEX PROPERTIES OF SOIL SAMPLE 1

PROPERTY	UNCONTAMINATED SAMPLE	CONTAMINATED SAMPLE
pH	6.2	4.5
Specific Gravity	2.55	2.97
Liquid limit	42	50
Plastic limit	30	25
Plasticity index	37	55
Shrinkage limit	22	15
Grain size distribution		
Sand	58.8	30
Silt	25	45
Clay	16.2	24
Compaction characteristics		
Maximum dry density(mg/m$^{3)}$	1.2	1.37
Optimum moisture content (%)	36	30

TABLE 4.INDEX PROPERTIES OF SOIL SAMPLE 2

PROPERTY	UNCONTAMINATED SAMPLE	CONTAMINATED SAMPLE
pH	5.5	4.23
Specific Gravity	1.9	2.55
Liquid limit	40	50
Plastic limit	30	25
Plasticity index	14.6	21.9
Shrinkage limit	22	10
Grain size distribution		
Sand	30.6	27.7
Silt	50.2	40.2
Clay	19.2	30.1
Compaction characteristics		
Maximum dry density(mg/m$^{3)}$	1.43	1.26
Optimum moisture content (%)	22	30

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TABLE 5.INDEX PROPERTIES OF SOIL SAMPLE 3

PROPERTY	UNCONTAMINATED SAMPLE	CONTAMINATED SAMPLE
pH	6.0	4.7
Specific Gravity	2.01	2.7
Liquid limit	55	75
Plastic limit	32	25
Plasticity index	25.5	40.15
Shrinkage limit	21.7	13
Grain size distribution		
Sand	50.8	55.7
Silt	32.1	28.1
Clay	17.1	27.6
Compaction characteristics		
Maximum dry density(mg/m$^{3)}$	1.25	1.45
Optimum moisture content (%)	21	25

C. *Preparation of soil samples for chemical analysis*

The soil samples collected were dried under shade by spreading them on plastic sheet s on ground. These air-dried samples were then sieved and soil passing through 2.00 mm sieve was taken for the analysis. These three samples were then mixed with the chemical reagents.300g of each soil sample were taken and mixed with 200 ml of Condy's crystal solution. Condy's crystals solution was prepared by mixing 10g of Condy's crystals with 200 ml of distilled water. The prepared solution was kept in a beaker. 150g of the mixture was kept in a beaker and left undisturbed for a period of 1 week. Another 150gg mixture was kept in another beaker and left undisturbed for a period of 2 weeks. The reaction taking place between the soil contaminants and Condy's crystals are represented as follows.

$$R+KMnO_4 \longrightarrow MnO_2 + CO_2 \text{ or } R_{ox} + \text{others}$$

R – Organic contaminant
R_{ox} - Oxidized intermediate organic compounds

Soil 1, Soil 2 and Soil 3 were mixed with Sodium Hydroxide in the next set of treatment. 300g of each soil sample were mixed with 150ml of 0.1N Sodium Hydroxide solution and kept in a beaker for further analysis. 150g of soil- sodium hydroxide mixture is kept in a beaker and left undisturbed for 1 week and another 150g of same mixture was kept in a beaker and left undisturbed for 2 weeks. The reaction taking place between sodium hydroxide and soil contaminants are as follows.

$$R+NaOH \longrightarrow NaR + H_2O$$

R – Organic contaminants

The three soil samples were also given phytoremedation. Arrowroot plants were used for the purpose of study, since they have very good contaminant absorption capacity. 3 kg of the representative samples were taken in a grow bag and single arrowroot plants were planted in it.

D. *Chemical analysis of soil samples*

Soil pH was determined using a standard pH meter according to IS: 2720(part 26, 1987). The ratio of soil to water ratio taken is 1:2.5. The salinity of the samples were determined using a conductivity meter with soil to water ratio 1:1.5. The organic carbon content of the soil samples were determined according to IS: 2720 (part 22, 1972). Cation exchange capacity was determined according to IS: 2720 (part 24, 1976).total soluble sulphates were determined according to IS: 2720 (part 27, 1977). Total nitrogen content was determined according to IS: 14684, 1999) using Macro-kjeldhal's flask method. The Phosphorous content was determined according to IS: 5305, 1969. The amount of potassium and sodium were determined using a Flame photometer. Figure 1 shows the soil samples mixed with Condy's crystals and Figure 2 shiws the soil samples mixed with NaOH solution.

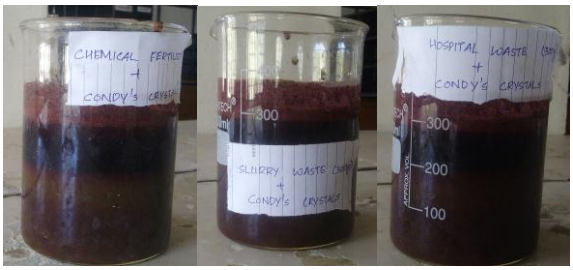

Figure 1. Soil Samples mixed with Condy's Crystals

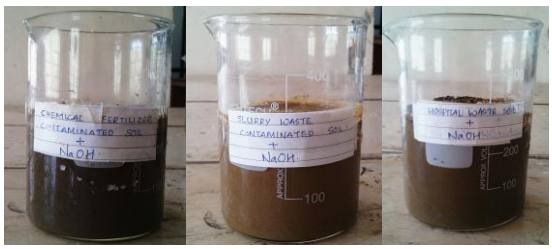

Figure 2. Soil samples mixed with NaOH

IV. RESULTS AND DISCUSSIONS

The soil samples kept for chemical analysis using two reagents were analyzed after two weeks and four weeks. The chemical analysis results are given in Table 6, Table 7 and Table 8.

Table 6 gives the results of first chemical analysis done to determine the amount of contaminants present in each type of soil before the treatment. Both normal soils samples and contaminated soil samples were given for the analysis. This analysis gives an idea about the extent of contamination in the three types of contaminated soils. Here TCC represents Total Carbon Content, CEC represents Cation Exchange Capacity, N represents Nitrogen content, P represents Phosphorous content, K represents Potassium content. NS denotes normal soil in all cases, HWS denotes Hospital Waste contaminated soil , CFS denotes Chemical fertilizer contaminated soil and SWS denotes Slurry Waste contaminated soils.

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Table 7 gives the results of chemical analysis of Hospital

TABLE 6. CHEMICAL ANALYSIS OF SOILS BEFORE TREATMENT

Soil type	pH	Salinity mm/ho	TCC (%)	CEC (meq)	C:N ratio	P kg/ha	K kg/ha
NS	6.2	2	0.76	75	25	50	22
HWS	4.5	4	0.9	50	32	75	40
NS	5.5	1.7	0.66	60	23	65	25
CFS	4.2	4.55	0.83	35	37	79	45
NS	6.0	2.37	0.7	55	27	57	23
SWS	4.7	5.0	1.1	100	34.5	69	49

TABLE 7. CHEMICAL ANALYSIS RESULTS OF HOSPITAL WASTE CONTAMINATED SOILTREATED WITH CONDY'S CRYSTALS

Time week	pH	Salinity mm/ho	TCC %	CEC	C:N ratio	P Kg/ha	K Kg/ha
2	5.5	2.9	0.85	65	29	60	32
4	5.9	2.5	0.80	71	27	54	28

TABLE 8. CHEMICAL ANALYSIS RESULTS OF HOSPITAL WASTE CONTAMINATED SOIL TREATED WITH NaOH

Time week	pH	Salinity mm/ho	TCC %	CEC	C:N ratio	P Kg/ha	K kg/ha
2	5.3	3.2	0.88	63	33	65	37
4	5.5	2.8	0.82	69	29	55	31

Table 9 and 10 gives the chemical analysis results of chemical fertilizer contaminated soil treated with Condy's crystals and NaOH respectively.

TABLE 9.CHEMICAL ANALYSUS OF CHEMICAL FERTILIZER CONTAMINATED SOILS SOILS TREATED WITH CONDY'S CRYSTALS

Time week	pH	Salinity mm/ho	TCC %	CEC	C:N ratio	P Kg/ha	K Kg/ha
2	4.9	3.01	0.75	48	30.1	73	36
4	5.2	2.32	0.70	52	26.5	67	29

TABLE 10.CHEMICAL ANALYSUS OF CHEMICAL FERTILIZER CONTAMINATED SOILS SOILS TREATED WITH NaOH

Time week	pH	Salinity mm/ho	TCC %	CEC	C:N ratio	P Kg/ha	K Kg/ha
2	4.6	3.23	0.8	45.1	32.5	75	40
4	5	2.57	0.73	53	28.7	69	33

Table 11 and 12 gives the chemical analysis results of slurry waste contaminated soils using Condy's crystals and NaOH respectively after 2 weeks and 4 weeks.

TABLE 11 .CHEMICAL ANALYSIS OF SLURRY WASTE CONTAMINATED SOILS TREATED WITH CONDY'S CRYSTALS

Time week	pH	Salinity mm/ho	TCC %	CEC	C:N ratio	P Kg/ha	K Kg/ha
2	5.5	3.9	0.98	75	31.3	64	38
4	5.7	3.01	0.87	68	29	59	29

TABLE 12. CHEMICAL ANALYSIS RESULTS OF SLURRY WASTE CONTAMINATED SOIL TREATED WITH NaOH

Time week	pH	Salinity mm/ho	TCC %	CEC	C:N ratio	P Kg/ha	K Kg/ha
2	5.2	3.99	0.97	76	32.4	67	41
4	5.6	2.98	0.83	70	28.1	60	33

Table 13 gives the chemical analysis results of Hospital waste contaminated soils after phytoremediation taken at 1.5,2.5 and 3.5 months.

TABLE 13 . PHYTOREMEDIATION RESULTS OF HOSPITAL WASTE CONTAMINATED SOILS

Time week	pH	Salinity mm/ho	TCC %	CEC	C:N ratio	P Kg/ha	K Kg/ha
1.5	4.9	3.7	0.87	49	30.7	72	36
2.5	5.8	3.00	0.82	60	28.2	63	30
3.5	6.5	2.5	0.78	69	26.4	57	28

Table 14 gives the chemical analysis results of chemical fertilizer contaminated soils subjected to phytoremediation, taken at 1.5,2.5 and 3.5 months.

TABLE 14 . PHYTOREMEDIATION RESULTS OF CHEMICAL FERTILIZER CONTAMINATED SOILS

Time week	pH	Salinity mm/ho	TCC %	CEC	C:N ratio	P Kg/ha	K Kg/ha
1.5	4.4	4.1	0.71	45	34.4	76	41
2.5	5.6	3.4	0.69	57	30.1	71	35
3.5	6.3	2.5	0.67	64	27.2	67	27

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Table 15 gives the phytoremediation results of slurry waste contaminated soils taken at 1.5, 2.5 and 3.5 months.

TABLE 15 . PHYTOREMEDIATION RESULTS OF SLURRY WASTE CONTAMINATED SOILS

Time week	pH	Salinity mm/ho	TCC %	CEC	C:N ratio	P Kg/ ha	K Kg/ ha
1.5	5.0	4.3	0.9	36.7	32	65	43
2.5	5.7	3.6	0.84	31.9	30.1	61	38
3.5	6.6	2.9	0.79	28.7	28.3	58	32

V.CONCLUSION

- The analysis showed that Hospital waste contaminated soils are highly contaminated than the other two soils.
- Slurry waste soils have the least rate of contamination.
- From the results of chemical analysis done in the three samples, it was found that treatments with Condy's crystals are more effective than the other two techniques of remediation.
- Treatment with NaOH is less effective than Condy's crystals and more effective that phytoremediation in concern with time as a factor in certain cases.
- It was found that phytoremediation also gave reliable results for the three types of contaminated soils.

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REFERENCES

[1] E.Wcislo, Soil contamination with PAHs in . Polish journal of Environmental studies, volume 7, No.5 (1998),267-272.
[2] Cheryl kluck and Gopal Achari: Chemical oxidation techniques for insitu remediation of Hydrocarbon impacted soils.
[3] Thahseen A.S.Sayara; Bioremediation of polyaromatic hydrocarbons (PAHs) contaminated soil process evaluation through composition and anaerobic digestion approach.
[4] Achugasim .O, Ojinnake C.M, Osuji L.C, potassium permanganate as an oxidant in remediation of soil polluted by Bonny light crude oil: Sky journal of Soil Science and Environmental management vol.3(2),4 -9
[5] Insitu chemical oxidation using $KMnO_4$ by U.S Department of Energy, September 1999