

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Issue 7, July 2015

Remediation of Heavy Metal Contaminated Soils

J.Aruna¹, Dr.B.Naga Malleswara Rao²

M.E Student, Department of Civil Engineering, VNR Vignana Jyothi Institute of Engineering and Technology,
Hyderabad India¹

Professor & HOD, Department of Civil Engineering, VNR Vignana Jyothi Institute of Engineering and
Technology, Hyderabad India²

ABSTRACT: Soil is a very unique part of the natural and agricultural aspects of eco-system. Soil contamination is mainly due to the uncontrolled release of hazardous wastes like petroleum products, heavy metals and above ground oil spills. This paper aims to investigate on the study of Decontamination of soils, contaminated with heavy metals like lead, Zinc, Chromium, Cobalt, Cadmium using several remediation techniques like soil washing and Phytoremediation and. The Geo-Environmental properties of the contaminated soil which is artificially contaminated and virgin soil could be monitored by the basic index properties of soil, Total Organic content (TOC), variation of pH, Electrical conductivity. The Extent of metal concentration could be analyzed by Atomic Absorption spectrophotometer (AASPM). Thus, the volume of the contaminants and toxicity in the soil would have been reduced. The Decontaminated soil could be used in the Engineering and non-engineering aspects..

KEYWORDS: Remediation techniques, Geo-Environmental properties, Heavy metals, AAS.

I. INTRODUCTION

Contamination is one of the most wide-spread group of heavy metal pollutants that contaminate the air, water, and land constituting a major global problem. A wide range of human activities are responsible for exposure, distribution, and mobilization of heavy metals into or in the environment. Rapid industrialization and urbanization have led to serious deterioration of the quality and value of the land, water, and air. Several methods are in practice for removal of heavy metals. Phytoremediation process, inculcates the use of several sequential crops of selected plant species and they can be cultivated to reduce the concentration of heavy metals in contaminated soils to environmentally acceptable levels (Zhen *et al*, 2002). Heavy metals can be translocated to above ground plant parts.

The main aim of this paper is to investigate the level of removal efficiency achieved by cultivating Sunflower species (*Helianthus Annus*) by the process of Phytoextraction. Phytoextraction or Rhizodegradation is the use of plants to remove contaminants from soil by accumulation in plant tissue and this is a promising clean-up technology for a variety of metal containing soil (Fuhrmann *et al*, 2002 Lasat, 2002). In the phytoremediating process, several sequential crops of selected plant species can be cultivated to reduce the concentration of heavy metals in contaminated soils to environmentally acceptable levels (Zhen *et al*, 2002). Heavy metals can be translocated to above ground plant parts.

II. RELATED WORK

Soil decontamination is possible by a Natural biological system called “phytoremediation” that has safe, efficient and cost effective solution for remediation of soil contaminated by wide array of contaminants. Phytoremediation originated from two words phyto (in Greek) means plant and Remedium (in latin) means restoring balance. The main aim of the phytoremediation to assimilate organic and inorganic contaminants to be degraded or transformed into harmless

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Issue 7, July 2015

metabolites or volatilized into the atmosphere. It is an environmental friendly and cost-effective to current remediation technologies. The procedure involved in this system are as follows

1. Different types of soils are taken out of one is artificially contaminated by adding different metal metal concentrations in the required levels, (here 10ppm). mixing the soil manually for uniform distribution of metal concentrations and left it for 24 hours.
2. Soil sample is tested for all its Geotechnical and Environmental properties listed in the table below 1.1.
3. soil is taken into one replica of pot and the sunflower (*helianthus annuus*) seeds are to be allowed for germination and plantation
4. By the Metabolism of Phytoextraction the contaminants present in the soil can be degraded or transformed in to harmless metabolites or volatilized into atmosphere. Thus the heavy metal concentration left over in the soil can be detected by means of Atomic Absorptio Spectrophotometer (AAS).
5. AAS is used as an spectroanalytical procedure for the quantitative determination of chemical elements using the absorption of optical radiation (light) by free atoms in the gaseous state.
6. Extent of metal concentrations left over after the remediation is listed in the table 1.1. sample results for the soil Analysis is shown in the figures (c) (d) (e). Thus the highest efficiency can be observed by the phytoremediation technique.

III. EXPERIMENTAL PROGRAM

Materials

Two different types of soils were taken mainly Black cotton, Sand taken in and around Husain sagar Hyderabad.

Black cotton Black Cotton Soil was used in this study obtained from SRR heights construction site at a 3 km distance from VNR VJIET Hyderabad.. The soil Sample was tested for index properties and artificially contaminated with the following metal solution standards such as Pb, Cu, Cr, Co uniformly distributed with the concentration of 10ppm
Sand was obtained from Husain sagar site in Hyderabad.

Experimentation

Basic Geo-Environmental Tests:

Specific gravity

The Specific gravity (G) of the soil has been determined by exploited some density bottle and pycnometer as per the guidelines provided by [3]. The average value has been taken from the three trials was obtained and the results for different soils are shown in the table.

Hydrometer test

According to IS: 2720 (part 4)-1985 the wet sieve analysis and hydrometer tests are conducted to determine the particle size of the soils

Liquid limit and plastic limit

According to the IS: 2720 (part V) - 1985 the liquid limit (LL) and plastic limit (PL) are conducted.

Standard Proctor test

According to IS: 2720 (part VII) - 1985 the standard proctor test conducted to determine the Optimum Moisture Content (OMC) and Maximum Dry density (MDD) of the soil.

PH test

Standardize the electrodes the instrument with electrodes immersed in a Acetate buffer (pH = 4). After rinse ,bloat dry the electrodes, Standardize the instrument in Ammonium buffer (pH = 10). Dip the pH electrode in the soil sample to be tested

Electrical conductivity

According to the test 1:5 soil suspension is prepared . Calibrate the conductivity meter according to the KCl reference solution to obtain cell constant. Rinse the Cell thoroughly to measure electrical conductivity for standard 0.01MKCl solution at same temperature as the soil suspension by using conductivity meter cell. Rinse the conductivity cell with the soil suspension and refill the conductivity cell without disturbing the settled soil to Record the value indicated on the conductivity meter.

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Issue 7, July 2015

Organic content

According to ASTM D 2974 – Standard test Methods conducted for Organic Matter of Peat and Organic Soils to determine the Organic content.

PHYTOREMEDIATION TECHNIQUE

1.5 kg of soil is contaminated with 10 Ppm of heavy metals such as Cr, Co, Pb,Cd,Cu mixed in uniform proportions and left for 24hrs.Then the sunflower(*helianthus annus*) is harvested in one replica of pot with several seeds.

Duration of Growth of the plant

From Mid February to Early March (22nd march to 8th April) ,the features of the plant are noted at different parts mainly in root and shoot levels.

Criteria for Decontamination

Plant extracts the metal concentration present in the soil and the Extent of metal concentration left over is evaluated by means of AAS (Atomic absorption spectrophotometer)

IV. EXPERIMENTAL RESULTS

Figures shows the results Of the soils collected in and around the Hyderabad city. These soils have been analysed for various physical and mechanical properties and the properties are as listed in the **Table 1.0**

Table 1.0 Properties of soil

Properties of soil	Black cotton soil	
	Contaminated soil	Decontaminated soil(phytoremediation)
Specific gravity	2.56	2.77
Clay (%)	25.7	25.7
Silt (%)	48	48
Sand (%)	0	0
Plastic limit(%)	36.78	71
Liquid limit(%)	32.12	69
OMC	15	40
pH	9.04	8.87
Electrical conductivity(mS)	2	2
Organic content(%)	73.6	30

Table 1.1 Extent of Metal concentration

Type of metal	Extent of metal concentration added(ppm)	Metal concentration left after phytoremediation (ppm)
Cu	10	1.83
Cd	10	0.35
Co	10	0.75
Pb	10	0.63
Zn	10	0.72

Tables 1.0 and 1.1 shows the Geo-Environmental properties of contaminated and decontaminated soil and the Extent of metal concentration for metals copper,cadmium,cobalt,lead, Zinc from 10ppm to the 1.83,0.35,0.75,0.63,0.72 respectively after phytoremediation. Thus the overall efficiency is evaluated using Atomic absorption spectrophotometer (AAS)

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Issue 7, July 2015

Figs. 1, shows the plantation of sunflower and testing the soil sample (a) shows the plantation of sunflower in artificially contaminated soil, Distance between the adjacent roots, length of the plant can be also noted. Thus the contaminants can be degraded with in cell structures of plant or volatilized in the atmosphere(b) shows the Atomic Absorption spectrophotometer(AAS) used for the soil Analysis for metal concentration .(c) Testing the Soil sample using AAS.



(a)

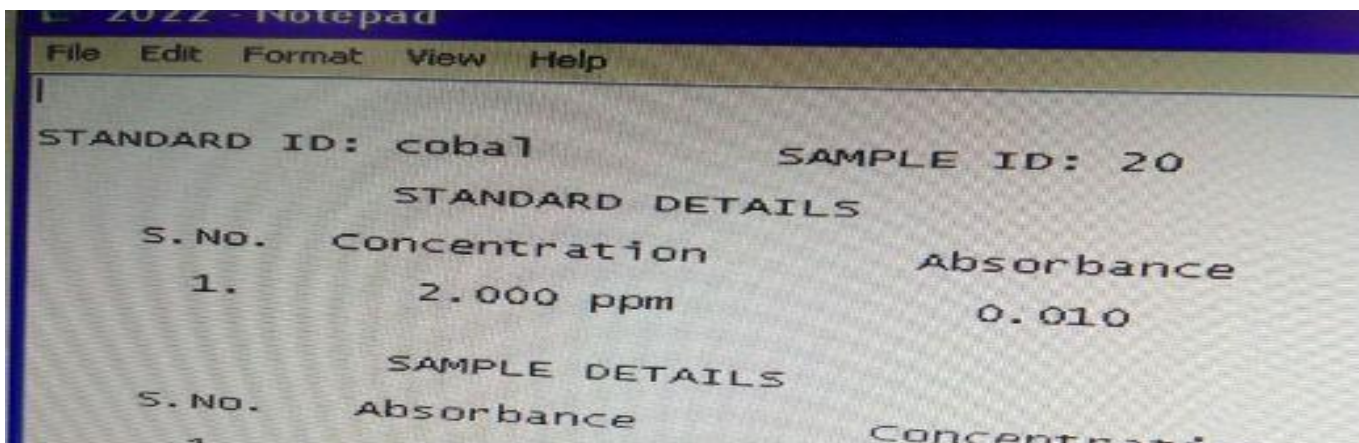


(b)



(c)

Fig. 2.) steps involved for soil analysis Using AAS and Outputs from the AAS for the Decontaminated soil sample(a)Extent of Copper (Cu)Co concentration after phytoremediation technique (b) extent of the meta leadl Pb concentration left in the soil sample



STANDARD ID: coba1			SAMPLE ID: 20	
STANDARD DETAILS				
S.No.	Concentration		Absorbance	
1.	2.000 ppm		0.010	
SAMPLE DETAILS				
S.No.	Absorbance		Concentration	
1				

Fig.(a)

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Issue 7, July 2015

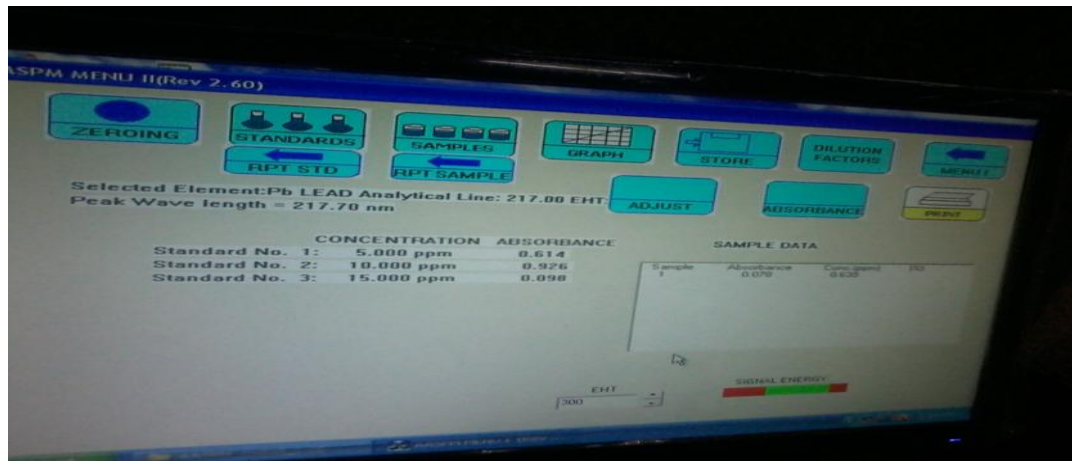


Fig.(b)

Thus the above figures (i) and (ii) clearly represent the soil analysis of artificially contaminated soil (Black cotton soil) by using the Phytoremediation technique by *helianthus annuus* for different metals with high efficiency

V. CONCLUSIONS

From the results obtained by the phytoremediation technique, the efficiency of the artificially contaminated black cotton soil is around 75-80% by *helianthus annuus* using AAS. The Geo-Environmental properties such as pH, organic content have been decreased, optimum moisture content, liquid limit (LL), plastic limit (PL), Specific gravity (G) have been decreased considerably for decontaminated soil. From the references and observations it is to be concluded that Phytoremediation is more economical and environment friendly too in Geotechnical and Environmental aspects alternative to current remediation technologies.

REFERENCES

- [1] IS 2720-Part 4, "Grain Size analysis, Bureau of Indian Standards", New Delhi, India, 1985.
- [2] IS 1498, "Classification and identification of soils for general engineering purposes", Bureau of Indian Standards, New Delhi, India, 1970.
- [3] IS 2720-Part 3, "Determination of specific gravity, Bureau of Indian Standards", New Delhi, India, 1980.
- [4] IS 2720-Part 7, "Determination of water content-dry density relation using light compaction", Bureau of Indian Standards, New Delhi, India, 1980.
- [5] Knight B, Zhao F. J, McGrath S. P, Shen Z. G. ; "Zn & Cd uptake by the hyperaccumulator *Thlaspi caerulescens* in contaminated soils and its effects on the concentration and chemical speciation of metals in soil solution", Plant & Soil 197, 71-78, 1997.
- [6] Jiang X. J, Luo Y. M, Zhao Q. G, Baker A. J. M, Christie P, Wong M. H. ; "Soil Cd availability to Indian mustard and environmental risk following EDTA addition to Cd-contaminated soil". Chemosphere 50(6), 813-818, 2003.
- [7] McIntyre Terry: "Phytoremediation of heavy metals from soils", Advances in Biochemical Engineering/Biotechnology 78, 97-123, 2003.
- [8] Deuel, L.E and Holliday, G.H, "Soil Remediation for the petroleum Extraction Industry", Pennwell publishing Company, Tulsa Okla, 1994.