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TREATMENT OF LANDFILL LEACHATE BY PHYTOREMEDIATION

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Abstract— Phytoremediation has been widely used for the wastewater treatment technology. In this study Eichhornia Crassipes (Water Hyacinth) has been used to investigate its capacity to remediate for heavy metals Chromium, Zinc, Nickel, chemical parameters; BOD, COD, pH, Total hardness, Sulphate and Physical parameters; TSS and TDS in landfill leachate. This plant seemed to be an effective choice due to its ability to survive in extreme to moderate conditions and also since it is a perennial plant. Conducted by placing the plant biomass into a high density polyethylene (HDPE) tub (14 liters) filled with the leachate sample exposed to natural conditions. The plant performed extremely well in removal of Nickel and Zinc i.e. 95.65 % and 92.31% respectively. It was capable of removing TSS and TDS by 90% and 79.57% respectively after a period of 15 days. The plants couldn't survive in the leachate for long, the leaves of the plants due to the toxicity of the leachate was unable to survive for the entire 15 day research period.

Keywords— Leachate Treatment, Phytoremediation, Eichhornia Crassipes, Removal of Heavy metals

INTRODUCTION

A Leachate is any liquid that in course of passing through matter, extracts soluble or suspended solids or any other component of the material through which it has passed. In case of Municipal Solid Waste disposal, leachate comes from waste decomposition process of solid waste. Since many heavy metals are highly toxic when the concentration exceeds certain limits they need to be treated [1].The Leachate samples were collected from the Moshi Landfill Located in Moshi, Pune. The prevailing purification technologies used to remove the contaminants are too costly and sometimes non-ecofriendly also. Therefore the research is oriented towards low cost and eco-friendly technology for treatment of Leachate. The treatment technology adopted is phytoremediation. The use of plant to remediate pollutant from nature is called phytoremediation. Phytoremediation represent an economical opportunity for pollutant removal based on the plants ability to extract, filter, absorb, stabilize, accumulate and volatilize pollutant [12]. In future it is expected that many landfills will be required to release their leachate directly to the environment. The study presented here is a part of a project that aims to meet these future demands by searching for new methods for treating leachate from landfills [4]. The environmental benefit of treatment of landfill leachate by phytoremediation includes; decreased energy consumption by using natural processes rather than conventional; efficiently removed many pollutants from wastewater and also enhance the environment by providing a habitat for vegetation, fish and other wildlife [9].

The treatment process is carried out for Physical, Chemical and Elemental (heavy metal) parameters of leachate. The main hazardous contaminants are Heavy metals. Aquatic macrophytes like water hyacinth absorb these metallic ions and deposit them in different parts of plant body depending upon their affinity towards the particular metal. The laboratory studies demonstrated the potential use of water hyacinth plants in removing metals from polluted water [2]. Water Hyacinth also substantially reduces the physical parameters such as Total suspended solids; Total dissolved solid and chemical parameters such as COD, BOD, pH, Total Hardness as $CaCO_3$, Sulphate as SO_4 of the Leachate.

Works done by different scientist prove that when macrophytes such as water hyacinth have their roots submerged they help in removing pollutants from the sample by an efficient Root system [11]. They also help in reduction of pollutants such as heavy metals by extracting it from the sample and in many cases storing it preferentially in the roots and rhizomes [10]. Since the water hyacinths are so prolific, harvesting them for industrial use serves also as a means of environmental control [6]. This research is done to determine the degree of treatment of a leachate sample using a low-cost, eco-friendly method of phytoremediation, since most of the other methods are expensive, require high energy and are not able to completely remove the heavy metals [3].

MATERIALS AND METHODS

Three heavy metals; Chromium, Zinc, Nickel were selected for study. Eichhornia crassipes was selected as study plant for removal of Chromium, Zinc and Nickel under the experimental condition. The plant has been used in the remediation process because it has elaborate root system providing much binding sites for heavy metals [5]. In their normal states, metals cannot be taken into any organism therefore they need to be dissolved as an ion in solution to give mobility in an organism[9].The first thing that happens when a metal is absorbed is it binds to the root cell wall [7].These metals are regulated in plants when available in the rhizosphere [8]. The plants of Eichhornia crassipes were collected (1500gm) from the site (Mula River, Pune) and kept in an HDPE tub in open, providing natural conditions. 5 liters of leachate was poured into the tub of capacity 14 liters. Tap water was added in order to compensate for water loss through plant transpiration, and evaporation due to high prevailing temperature during the study. 1500 gm of Eichhornia crassipes was carefully placed in the tub. Observations were recorded for amount of heavy metals after 3, 7, 11 and 15

days. Results are expressed in terms of % loss / absorption of heavy metals from water assuming that amount depleted is absorbed by the plant biomass. The detection

RESULTS AND DISCUSSION

The results received from the laboratory regarding the changes in the values of parameters after treating the Leachate sample by phytoremediation have been clearly depicted in Table 1 in order to get an unambiguous understanding of the improvement achieved. The Elemental parameters in the Leachate namely Chromium, Nickel, Zinc have reduced by 51.66%, 95.65%, 92.31% by the 15th day of the treatment process respectively (Table 1). These gradual reductions in the parameters have been illustrated in fig (1), fig (2) and fig (3). From the percentage reduction calculated in table 1 it is evident that the plant biomass has absorbed considerable amount of heavy metals and has treated the leachate sample. The tabular representation of the physical parameters namely, TSS (Total suspended solids) and TDS (Total dissolved solids) have shown a percentage removal of 90 % and 79.57% respectively (Table 1). The chemical parameters such as COD, BOD, and Total Hardness have also shown a considerable amount of reduction after treatment that is 54.19%, 62.57%, 78.39% respectively (table 1). The pH has been neutralized from a value of 6.37 to 7.05 (Table 1).The values of Heavy Metals were treated below detectable limits which make the leachate sample suitable for disposal in retrospect with the raw leachate sample

Elemental Parameters

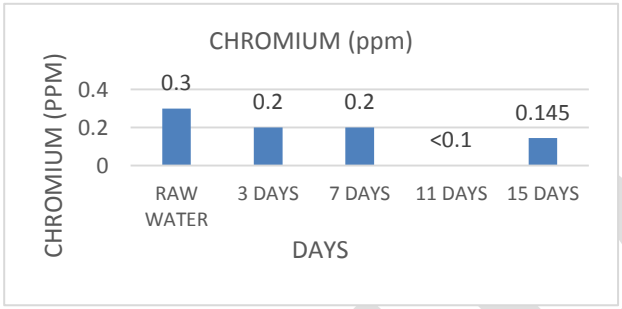

Figure 1: Comparison of Chromium reduction over the sampling period of 15 days

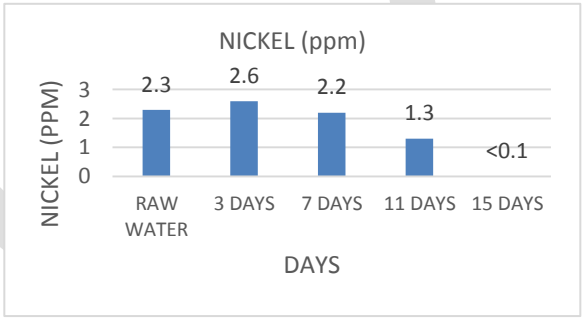

Figure 2: Comparison of Chromium reduction over the sampling period of 15 days

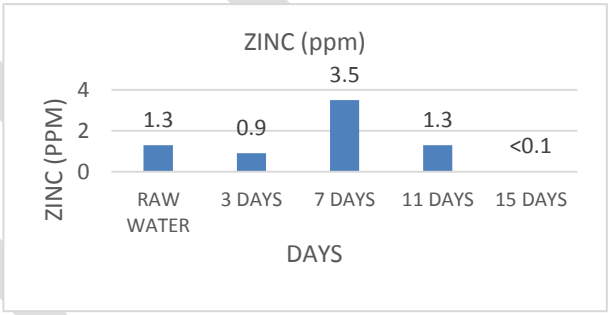

Figure 3: Comparison of Zinc reduction over the sampling period of 15 days

SR NO	PARAMETERS	UNITS	RAW WATER	WATER HYACINTH				PERCENTAGE REMOVAL %
				3 DAYS	7 DAYS	11 DAYS	14 DAYS	
	PHYSICAL							
1	TSS	gm/lit	4	1	0.3	0.1	0.1	90 %
2	TDS	gm/lit	7	5.8	5.2	3.8	1.43	79.57%
	CHEMICAL							
1	COD	mg/lit	44200	30000	31800	22666	20244	54.19%
2	BOD	mg/lit	18700	12800	13600	9400	7000	62.57%
3	pH	-	6.37	6.78	7.08	7.26	7.05	--
4	Total Hardness as $CaCO_3$	gm/lit	11.2	8.9	8.7	6.8	2.42	78.39%
5	Sulphate as SO_4	ppm	<10	<10	<10	<10	<10	--
	HEAVY METALS							
1	Chromium	ppm	0.3	0.2	0.2	<0.1*	<0.1*	51.66%
2	Nickel	ppm	2.3	2.6	2.2	1.3	<0.1*	95.65%
3	Zinc	ppm	1.3	0.9	3.5	1.3	<0.1*	92.31%

***N.D- Not Detectable**

Table 1: Tabulation of values of Physical, Chemical and Elemental parameters at various stages of treatment with Water Hyacinth.

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CONCLUSION

With this research we conclude that macrophytes like water hyacinth work efficiently towards treatment of physical parameters, chemical parameters and elemental parameters of municipal solid waste leachate. From this research we obtained a low-cost and eco-friendly phytoremediation process which can be used effectively by the Moshi Landfill functioning under the governance of Pimpri Chinchwad Municipal co-operation. This method acts as a economical and effective alternative to the conventional methods of Leachate treatment.

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