

## International Journal of Innovative Research in Science, Engineering and Technology

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# Removal of Heavy Metal Lead (Pb) from Industrial Waste Water by Constructed Wetland

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**ABSTRACT:** Industries generate waste water, solid waste and gases which if released untreated in environment will cause much ill effect to environment and also are much hazardous to the living beings. This paper focus on removal of lead (Pb) which is major hazardous heavy metal released with waste water of electrochemical industry. Constructed Wetland offers economical and effective solution to remove many hazardous chemicals and heavy metals from waste water. Indian mustard plant species offers effective removal of lead (Pb) with proper substrate and environmental conditions. In this paper efficiency of lead removal is tested by Indian mustard with continuous flow rate from 1 day, 3 days, 5 days, 7 days and 10 days respectively for different Lead concentration i.e. 8 ppm, 10 ppm, 12 ppm, 14 ppm and 16 ppm. Almost 83% of Lead removal is noted for constructed wetland using Indian mustard.

**KEYWORDS:** Constructed Wetland (CW), Indian mustard, battery industry waste water, Substrate, Flow rate, Retention period, Heavy Metal.

### I. INTRODUCTION

Lead-acid batteries contain chemicals that can be hazardous to health and the environment. Extreme lead poisoning can result in coma, convulsions, irreversible mental retardation, seizures and even death. This harmful substance permeate into the soil, groundwater and surface water through landfills and also release toxins into the air when they are burnt in municipal waste combustors. Acid battery industrial waste constitutes the major source of various kinds of metal pollution in natural waters. The major toxic metals are Zn, Ni, Pb which in turn will be released to natural water bodies and contaminate it.

Along with the human health lead also have adverse effect on nautical life. So it is at most necessary to remove this hazardous metal from waste water before it will have access to natural water bodies or Public sewers.

Different methods are being practiced to remove these heavy metals from waste water. Constructed Wetland offers much effective economical and eco friendly process to remove different organic and inorganic impurities. The understanding of the mechanisms that drive removal of these contaminants is crucial with what type of constructed wetland being selected.

Wastewater wetlands encompass many processes and mechanisms in the removal of contaminants. The Basic three are physical, biological, and chemical removal processes. Physical processes are often used in primary treatment of traditional wastewater treatment systems. The processes are no different than in wetlands. Water that flows through wetlands moves rather slowly due to resistance from plant matter and a uniform sheet flow of water. The plants in the wetland help trap sediment but not as much as sediment that settles from lower velocity. This low flow allows particles to settle out and this is also helped by laminar flows in most wetlands. By using gravity and the differences in relative densities of suspended material, particles are allowed to settle in the wetland.

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Vol. 6, Issue 6, June 2017

Table 1 shows the ISI Tolerance Limit of Lead (Pb) for sewage and Industrial Effluents and that of Inland surface water

Table 1

	Tolerance Limits for Effluents discharged into-		Tolerance limits for inland surface water, when used as raw water for public water supplies and bathing Ghats (IS 2296-1974)
	Inland surface water (IS:2490-1974)	Public sewers (IS:3306-1974)	
<b>Lead mg/L</b>	0.1	1.0	0.1

## II. MATERIALS AND METHOD

### Materials

#### i) Substrate:

Sub grade is provided in five layers. Four layers are provided with 35 to 45 mm size boulders, 25 to 28mm size coarse aggregates, 18 to 20 mm aggregates, 8 to 10mm coarse sand of each 80mmthick. Soil is provided over for 100mm thickness to plant seeds.

#### ii) Lead Concentration:

Waste water from the battery industry is collected from the electrochemical industry and the concentration of lead was tested for the experiment to be carried out. This concentration of lead was 12ppm. It is also the focus of study to know the optimum lead concentration for the wetland study to provide better results. In this line, five stock solutions were prepared i.e. 8ppm, 10ppm, 12 ppm 14 ppm and 16ppm.

#### iii) Plant Species:

Plant under category ‘Emergent’ is selected for this experiment as the wetland model suited for the said category. From these categories the plant selected for the said impurity Lead (Pb) is Indian mustard. In general, plants do not absorb or accumulate lead. But certain plants, such as the sunflower and Indian mustard, absorb remarkably large amounts of metals compared to other plants and actually survive. After the plants are allowed to grow on a contaminated site for a period of time with proper soil amendments to mobilize the metal, they are harvested. After this, they are either disposed of as a hazardous waste or incinerated (and the metals recycled). In the experiment all three compartments are seeded with Indian mustard seeds and harvested it for one month. Seeding is done at ten different locations at all compartments. After this time period fibrous roots of plants will be in a position of experimental work. Following figure 1 shows the grown up plants for experiment.

#### iv) Laboratory Scale Model:

##### Horizontal continuous flow rate constructed wetland laboratory size model.

Rectangular tank made up of glass 12mm thick with dimension 450mm wide x 450mm deep and 1200mm long is used. Two baffles at 1/3<sup>rd</sup> length are provided to increase the travelling period of water. Bed slope of 1% is provided for easy and proper drainage.

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Vol. 6, Issue 6, June 2017

## Method:

Wetland seeded with Indian mustard was harvested for period of 20 days before it fended with industrial waste water.

### i) Flow Rate:

Flow rate was decided from different rates varying from 1LPH to 12LPH and then fix the suitable rate which allows continuous rate without saturation of water in the wetland. Out of above flows rates the rates 1LPH is suitable for the experiment

### ii) Retention Time:

Five retention times was planned to be tested as 1 day 3 days, 5 days, 7 days and 10 days. Lead concentrations were tested for above retention times for the optimum test results. Figure 1 shows the complete setup for project.



Figure 1: Project setup with grown up plants

## III. RESULTS AND DISCUSSION

Indian mustard has proven to be Eco- friendly and economical option for lead removal. It is also less hazardous to the health and imparts beauty to the environment.

### A. Controlled Check(without plantation)

Controlled check is carried out for the same concentration i.e. for 12 ppm inlet Pb concentration for stated retention time. Following Table 2 and Figure 2 shows the results.

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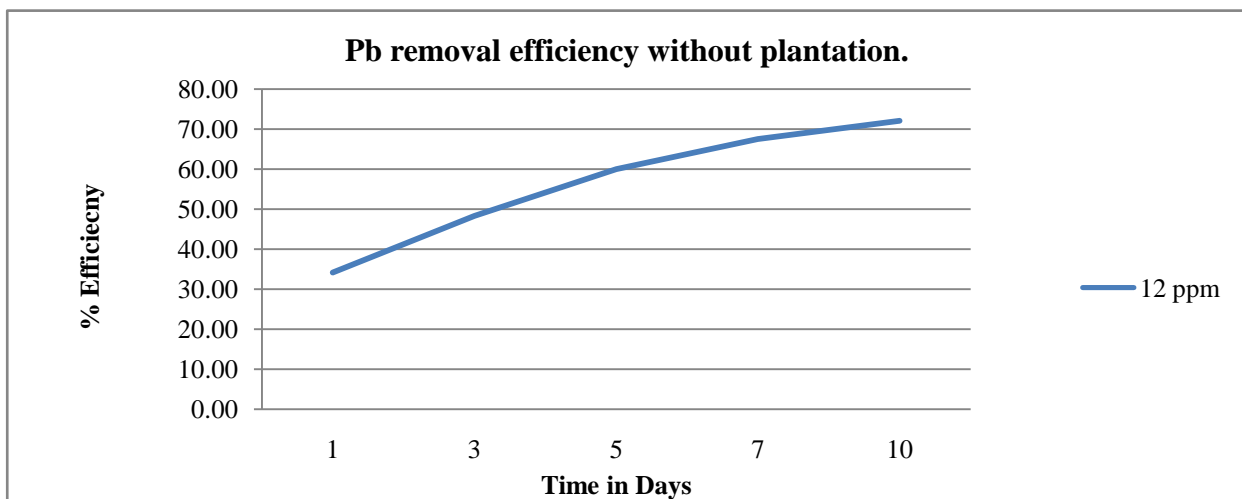
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Vol. 6, Issue 6, June 2017

**Table 2-Result for 12ppm inlet lead concentration (without Plantation)**

S.N.	Retention Time (days)	Pb Concentration(ppm)
1	1	6.400
2	3	5.200
3	5	4.400
4	7	3.200
5	10	2.640



**Figure 2-Depletion of Pb without plantation 12ppm inlet Lead Conc.**

**Discussion:** It can be understood by above results that about 72% of Lead is removed from constructed wetland alone. This efficiency of wetland is enhanced with the plantation of Indian mustard.

### B. Lead (Pb) removal efficiency for different Pb concentration and retention time

Following table 3 shows the results for 12 ppm Inlet Lead concentration (with Plantation).

**Table 3 -Result for 12ppm inlet lead concentration (with Plantation)**

S.N.	Retention Time (days)	Pb Concentration (ppm)
1	1	10.91
2	3	7.800
3	5	4.600
4	7	2.400
5	10	2.160

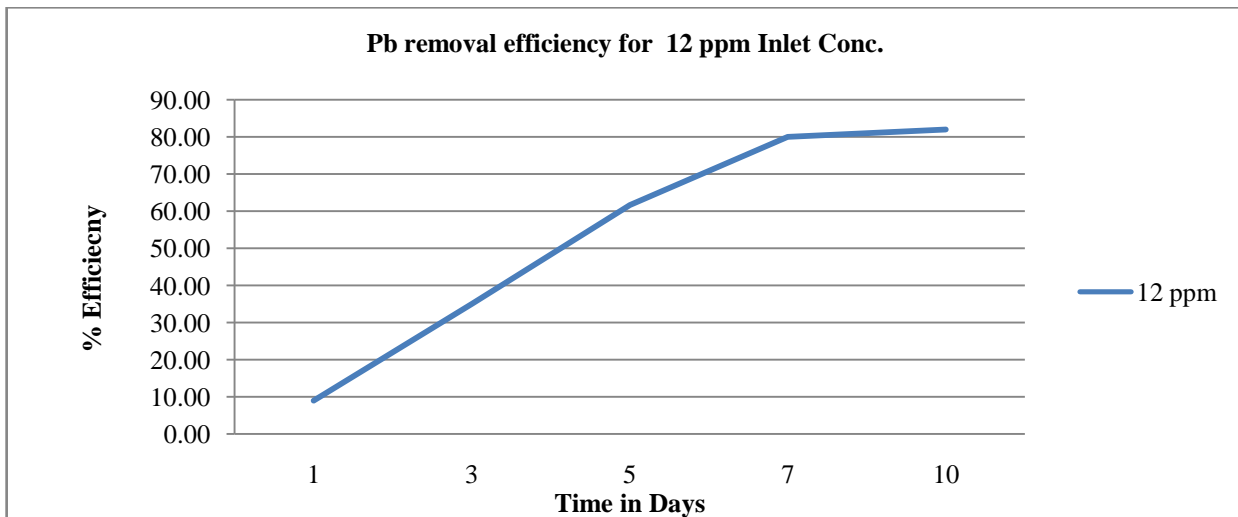
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(An ISO 3297: 2007 Certified Organization)

Website: [www.ijirset.com](http://www.ijirset.com)

Vol. 6, Issue 6, June 2017

**Discussion:** Pb removal efficiency for Wetland without plantation is about 72% and that of with plantation is 83%. From the above results it can be understood that the wetland efficiency is increased by Indian mustard plantation, it is beneficial to plant metal extracting plants in wetland to improve its efficiency. About 8-9 % efficiency can be enhanced with the use of plantation in connection with constructed wetland. Also it will not add any additional cost; plantation in connection with existing wetland will improve the capacity as a whole. Figure 3 shows the efficiency of Lead removal for 12 ppm inlet concentration. Table 4 and figure 4 shows Relative results and graphs for all ppm concentrations.



*Figure 3 - Pb removal efficiency with plantation 12ppm inlet Lead Conc.*

**Table 4.Result for 8-16 ppm inlet lead conc.**

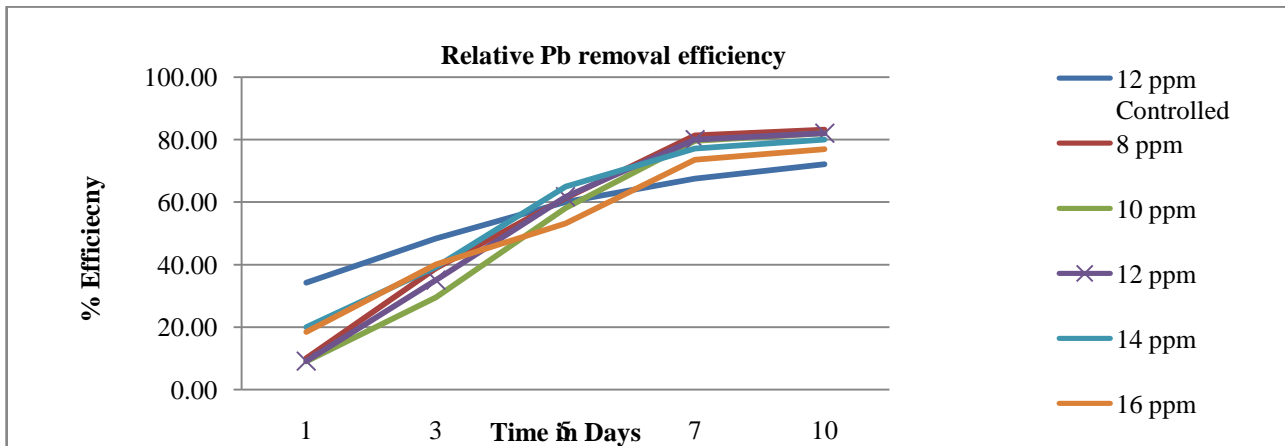
S.N.	Time (days)	Pb 8(ppm)	Pb 10(ppm)	Pb 12(ppm)	Pb 14(ppm)	Pb 16(ppm)
1	1	7.200	9.100	10.910	11.200	13.050
2	3	4.900	7.050	7.800	8.500	9.600
3	5	3.100	4.200	4.600	4.900	7.500
4	7	2.300	2.300	2.400	3.300	4.240
5	10	1.500	2.050	2.160	3.050	3.700

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(An ISO 3297: 2007 Certified Organization)

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Vol. 6, Issue 6, June 2017



**Figure 5– Cumulative Pb removal efficiency.**

The results and graphs above indicate the optimacy of the wetland model and Indian mustard for removal of lead from waste water.

Following figures 6 will provide a sight on the accumulation of the lead on stem and on shoots clearly.



(a) Color before Experiment



(b) Color After Experiment

**Figure 6 (a), (b)-Color change for shoots**

### IV. CONCLUSION

- Efficiency of Lead removal for the constructed wetland (without plantation) is 72%.
- Efficiency of Lead removal for the constructed wetland (with plantation- Indian mustard) is 83%.
- Use of Plants for constructed wetland enhance the efficiency of wetland process
- Inlet Flow rate affects the wetland efficiency. Maximum flow rate will saturate the wetland and plant efficiency. It necessary to select the optimum flow rate depending on the wetland capacity.

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Vol. 6, Issue 6, June 2017

- Indian mustard plant will effectively remove lead from lead contaminated soil up to 14ppm inlet lead concentration up to certain extend.
- There was no significant result of study for 16ppm inlet lead concentration
- Constructed wetland doesn't involve costly material; equipment though offers efficient and cost effective solution for the treatment of contaminated soil.

## V. FUTURE SCOPE

Though the results are optimum, Efficiency of wetland can also be improved by some additional methods. Following are some of the techniques to improve the efficiency of wetland further.

### A] By adding chelating agents:

Chelating agents like EDTA (Ethylene diamine tetraacetic Acid) added to the soil will improve overall efficiency. EDTA will accelerate the extraction process and ultimately more Lead can be removed from soil. This addition of EDTA to soil needs no further setup. Additional 7-8% of Lead can be removed by addition of chelating agents.

### B] By using batch reactor and activated carbon.

Activated carbon such as charcoal or coconut shell activated carbons are proven to be low cost ingredients to remove heavy metals from waste water. These carbons will remove heavy metal from adsorption method.

Batch reactor with the use of activated carbon can remove considerable amount of Lead with minimum time requirement. Additional set up of batch reactor will be needed for this sequential treatment. It will increase some add on cost for the setup. Around 8-10% of additional Lead can be removed by this process.

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Vol. 6, Issue 6, June 2017

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