Removal of Lead from Synthetic Lead Solution by using Orange peel as a low Cost Adsorbent

Shilpa Chittora[1], Prof. Sagar Gawande[2]

[1]*Department of Civil Environmental Engineering, Anantrao Pawar C.O.E. & R.,Pune, India*
[2]*Department of Civil Environmental Engineering, Anantrao Pawar C.O.E. & R.,Pune, India*

Abstract - *Industrial uses of metals and other domestic processes have introduced substantial amounts of potentially toxic heavy metals into the atmosphere .Heavy metals have toxic and potentially damaging effect on human physiology and other biological systems. Lead is one of the heavy metal produced, which is highly toxic to human body systems.*
The aim of the paper is to examine the removal of lead by using the low cost adsorbent. In this study biosorption of lead ion is done from synthetic lead solution using orange peel column filter. The influence of adsorbent dose and contact time is to be studied to identify the adsorption capacity of the adsorbent.

Keywords: Lead, synthetic lead solution, adsorbent, Column filter.

1. INTRODUCTION

Water contamination by heavy metals is a major environmental problem. Rapid industrial development has increased the release of heavy metals in water bodies. Heavy metals are elements with an atomic density greater than 6 g/cm^3; they are one of the most persistent pollutants in wastewater. The most common toxic heavy metals in wastewater include arsenic, lead, mercury, cadmium, chromium, copper, nickel, silver, and zinc. Heavy metals are commonly released in the wastewater from various industries. Electroplating and surface treatment practices leads to creation of considerable quantities of wastewaters containing heavy metals (such as cadmium, zinc, lead, chromium, nickel, copper, vanadium, platinum, silver and titanium). Apart from this wastewater from leather, tannery, textile, pigment & dyes, paint, wood processing, petroleum refining industries and photographic film production contains significant amount of heavy metals.

The heavy metals present in the wastewater is persistent and non degradable in nature. Moreover, they are soluble in aquatic environment and thus can be easily absorbed by living cells. Thus, by entering the food chain, they can be bio accumulated and biomagnified in higher tropic levels also. The heavy metals, if absorbed above the permissible labels, could lead to serious health disorders. Therefore, it is obligatory to treat metal contaminated wastewater before discharging into the environment.

One of the heavy metal which is highly toxic and carcinogenic is lead. Lead is a heavy, soft, malleable, bluish grey metal. Because of high toxicity of Lead and its widespread presence in the environment it is considered as a priority pollutant. It is an industrial pollutant, which enters the ecosystem through soil, air and water. Lead ion is introduced into natural water stream through various industrial applications such as insecticide, storage battery manufacturing, paint, metal plating/finishing, ceramic and glass industries. The presence of high levels of lead in the environment may cause long-term health risks to humans and ecosystems. The inorganic forms of lead are absorbed through ingestion by food and water, and inhalation. A notably serious effect of lead toxicity is its teratogenic effect. Lead poisoning also causes inhibition of the synthesis of hemoglobin; dysfunctions in the kidneys, joints and reproductive systems, cardiovascular system and acute and chronic damage to the central nervous system.

According to the World Health Organization (WHO), the maximum permissible limit (MPL) of lead in drinking water is 0.05 mg/L. The permissible limit (mg/L) for Pb (II) in wastewater, given by Environmental Protection Agency (EPA), is 0.05 mg/L. In industrial wastewaters, lead-ion concentrations approach 200–500 mg/L; this concentration is very high in relation to water quality standards, and lead-ion concentration of wastewaters must be reduced to a level of 0.05–0.10 mg/L before discharging to water ways or sewage systems. Hence proper treatment of industrial wastewaters which are releasing lead into the aquatic and land systems is very important.

Various methods are used to removal of heavy metal from industrial effluents like chemical precipitation ION exchange adsorption; adsorption has emerged out as effective, economical and eco-friendly treatment technique. It is a process potent enough to fulfill water reuse obligation and high effluent standards in the industries. Adsorption is basically a mass transfer process by which a substance is transferred from the liquid phase to the surface of a solid, and becomes bound by physical and/or chemical interaction. It is a partition process in which few components of the liquid phase are relocated to the surface of the solid adsorbents. All adsorption methods are reliant on solid-liquid equilibrium and on mass transfer rates.

The efficiency of adsorption process is based on the capability of adsorbent to adsorb the metal ions from the solution onto its surface. Activated carbon has undoubtedly been the most popular and widely used adsorbent in wastewater treatment throughout the world but its applications are sometimes restricted due to their high cost. Thus, many researchers are interested in production of safe and low cost alternatives which would be agricultural waste, industrial wastes and by-products for the removal of heavy metals from wastewater.

In this paper , orange peel is used as an adsorbent and for adsorption process a column filter is prepared and experimental study is performed to evaluate the effectiveness of orange peel for removal of lead ion from synthetic lead solution and effect of contact time and adsorbent dose for lead removal has been studied.

2. MATERIALS AND METHODOLOGY

2.1 Preparation of Synthetic Lead Solution:

1. 0.1599 g Lead (II) nitrate manufactured by Thermo Fisher Scientific India Pvt. Ltd. In Mumbai of an assay 99% has been dissolved in 10 ml of diluted nitric acid (1 → 10)
2. Then the solution has been made up to a litre.
3. 1 ml of the solution so obtained contains 0.1 mg of lead (Pb) means stock solution of 100 mg/l concentration is prepared.
4. Synthetic waste water with desired concentration of lead was prepared using lead standard stock solution.

2.2 Preparation of Adsorbent:

1. Orange peels were collected and washed with water several times to remove ash and other contaminants.
2. Then Orange peels were sun dried for 5 days.
3. These dried orange peels were crushed in a domestic blender and sieved to small particles (2 mm sieve)

2.3 Preparation of Orange Peel Column Filter:

A semi –cylindrical hollow plastic container is used as column filter with 40 cm height and 10 cm internal dia.

1. Column filter is provided with supporting media of Zhama brick bats (40-55mm size), gravel (10-15mm size), and coarse sand (2-3 mm size) with bed depth of 7 cm, 5 cm and 4 cm respectively.
2. The supporting media acts as a natural filter and avoids clogging of collection pipe at the bottom.
3. Crushed Orange peel is put at top of the filter as an adsorbent of different quantity.

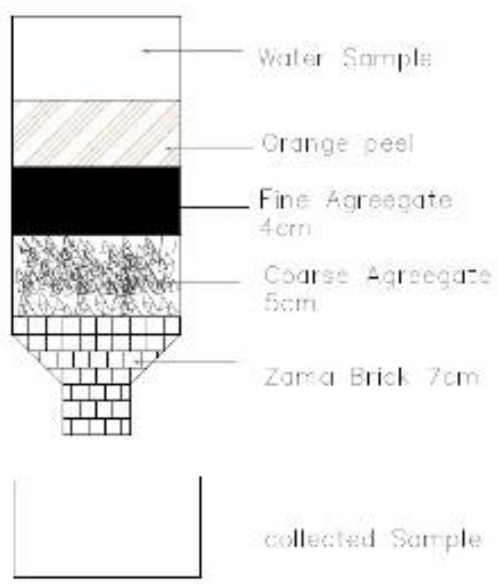

Fig 1: Experimental model of Column filter with orange peel

2.4 Experimental Procedure:

1. Synthetic wastewater of initial concentration of 40 mg/l was prepared by standard stock solution.
2. Column filter of different quantities of orange peel powder 50 gm, 100 gm, 150 gm and 200 gm was prepared. Filter has a layer of brick bat, gravel, coarse sand and peel powder at the top which act as an adsorbent.
3. Wastewater samples was poured inlet of column filter and samples from outlet was collected at regular interval of 5 min,15 min,20 min,30 min,40 min and 60 min from every filter model and collected accordingly.
4. Samples collected at every stage were analyzed by apha standards(American Public Health Association) to determine lead ion concentration by Atomic Adsorption Spectrometer.
5. The amount of metal ion adsorbed by orange peel was calculated as:

$$\% \text{ Adsorption} = ((C_0 - C_e) / C_0) \times 100$$

Where, C_0 and Ce are the initial and final concentration of adsorbate, respectively.

3. RESULT AND DISCUSSION

3.1 Model 1: 50 gm of quantity of orange peel

Table 1: % adsorption of lead by 50 gm orange peel with different retention time

Retention time (min)	Initial Lead Ion Concentration C_0 (mg/l)	Final Lead Ion Concentration C_e (mg/l)	% Adsorption
5	40	38	5
15	40	36.9	7.75
20	40	32.8	18
30	40	31.4	21.5
40	40	30.1	24.75
60	40	29	27.5

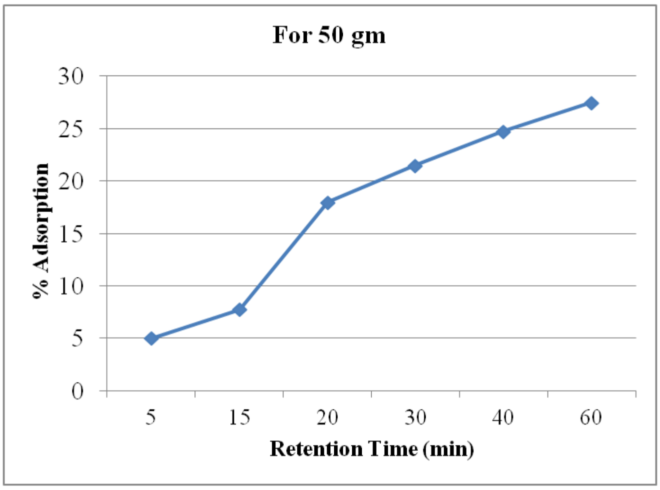

Chart 1: Effect of retention time on % adsorption of lead ion by 50 gm of orange peel

Chart 1 shows the effect of retention time on % adsorption of lead ion by 50 gm quantity of orange peel. Graph shows that % adsorption or removal of lead is increased with increase in time. Maximum 27.5% of adsorption by 50 gm orange peel was achieved at 60 minutes.

3.2 Model 2: 100 gm of quantity of orange peel

Table 2: % adsorption of lead by 100 gm orange peel with different retention time

Retention time (min)	Initial Lead Ion Concentration C_0 (mg/l)	Final Lead Ion Concentration C_e (mg/l)	% Adsorption
5	40	37	7.5
15	40	35.4	11.5
20	40	33	17.5
30	40	30	25
40	40	29	27.5
60	40	29	27.5

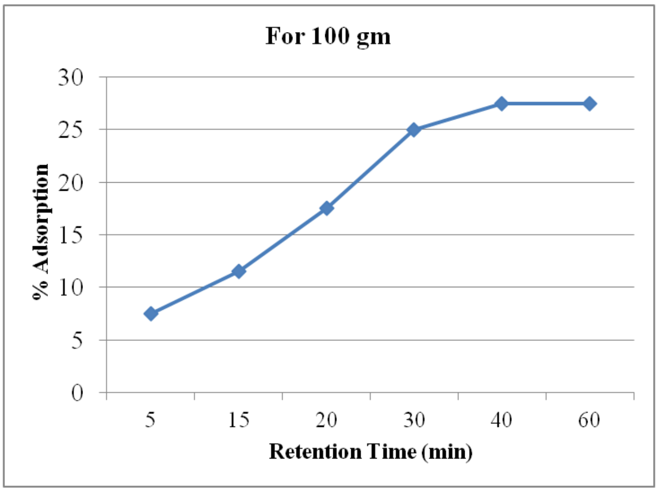

Chart 2: Effect of retention time on % adsorption of lead ion by 100 gm of orange peel

Chart 2 shows the effect of retention time on % adsorption of lead ion by 100 gm quantity of orange peel. Graph shows that % adsorption or removal of lead is increased with increase in time but after equilibrium there is no increase in % adsorption. Maximum 27.5% of adsorption by 100 gm orange peel was achieved at 40 minutes. From figure 2 and 3, we can say that for the same removal of lead ion from synthetic lead solution of 27.5% as we increase the quantity of adsorbent from 50 gm to 100 gm retention time will decrease from 60 min to 40 min.

3.3 Model 3: 150 gm of quantity of orange peel

Table 3: % adsorption of lead by 150 gm orange peel with different retention time

Retention time (min)	Initial Lead Ion Concentration C_0 (mg/l)	Final Lead Ion Concentration C_e (mg/l)	% Adsorption
5	40	36.4	9
15	40	34.2	14.5
20	40	29.9	25.25
30	40	26.8	33
40	40	24.6	38.5
60	40	24.2	39.5

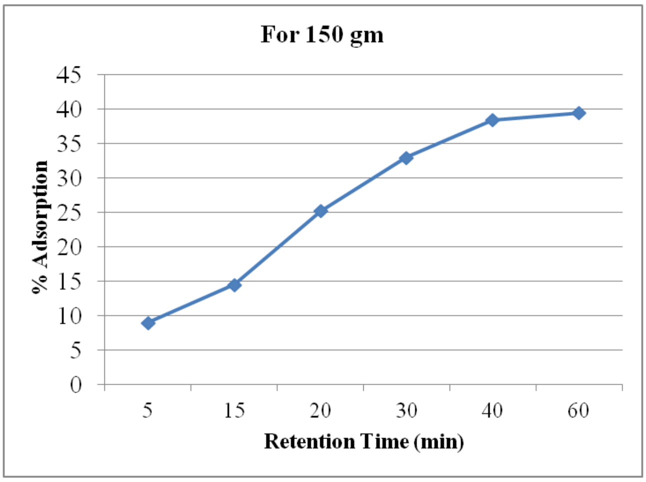

Chart 3: Effect of retention time on % adsorption of lead ion by 150 gm of orange peel

Figure 4 shows the effect of retention time on % adsorption of lead ion by 150 gm quantity of orange peel. Graph shows that % adsorption or removal of lead is increased with increase in time until equilibrium. Maximum 39.5% of adsorption by 150 gm orange peel was achieved at 60 minutes.

3.4 Model 4: 200 gm of quantity of orange peel

Table 4: % adsorption of lead by 200 gm orange peel with different retention time

Retention time (min)	Initial Lead Ion Concentration C_0 (mg/l)	Final Lead Ion Concentration C_e (mg/l)	% Adsorption
5	40	35.2	12
15	40	34.5	13.75
20	40	29.5	26.25
30	40	25.2	37
40	40	24.5	38.75
60	40	24.6	38.5

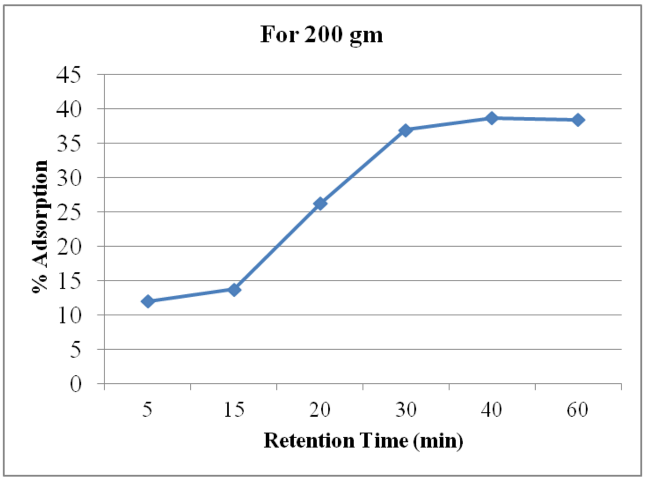

Chart 4: Effect of retention time on % adsorption of lead ion by 200 gm of orange peel

Chart 5 shows the effect of retention time on % adsorption of lead ion by 200 gm quantity of orange peel. Graph shows that % adsorption or removal of lead is increased with increase in time until equilibrium. Maximum 38.75% of adsorption by 200 gm orange peel was achieved at 40 minutes.
After increasing the quantity from 150 gm , there is no significant change in % adsorption of lead ion by orange peel.

4. CONCLUSIONS

It is concluded from this experimental study that orange peel is a cheap and effective adsorbent for removal of lead ion. Based on the Results we can conclude that removal of lead is directly proportional to the retention

time and adsorbent dose until equilibrium. The maximum removal of lead is 39.5% with 150 gm of orange peel at 60 minute retention time. The removal efficiency can be increased by pretreatment and modifications of orange peel. This process can be effectively used in lead and other heavy metal removal from effluent of small scale industries.

REFERENCES

[1] Abdel-Halim SH, Shehata AM, El-Shahat MF. Removal of lead ions from industrial waste water by different types of natural materials. Water Res. 2003; 37(7): 1678-83.

[2] Barakat M. New trends in removing heavy metals from industrial wastewater. Arab J Chem. 2011; 4(4): 361-77.

[3] Kirti Goyal, Shakti Kumar, R.K. KhitoliyaRemoval of Lead from Aqueous Solution by using Low Cost Adsorbent

[4] Ahsan Habib , Nazrul Islam, Anarul Islam and A. M. Shafiqul Alam Removal of Copper from Aqueous Solution Using Orange Peel, Sawdust and Bagasse

[5] Mondal MK. Removal of Pb (II) ions from aqueous solution using activated tea waste: Adsorption on a fixed-bed column. J Environ Manage. 2009; 90(11): 3266-71.

[6] Annadurai G, Juang HS, Lee DJ (2002) Adsorption of heavy metal from water using banana and orange peels. Water Sci Technol 47: 185-190.