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Adsorption of Pb (II) ions on *Tamarindous indica* seeds as a low cost abundantly available natural adsorbent

Shashikant R. Kuchekar[1]*, Vishwas B. Gaikwad[2] *, Dadasaheb V. Sonawane[3] and Shamarao P. Lawande[3]

[1]*P.G. Department of Environmental Science, P.V.P. College, Loni(KD), Rahata, Ahmednagar, M.S*
[2]*K.T.H.M. College, Nashik*
[3]*Shri Chhatrapati Shivaji College, Shrigonda*

ABSTRACT

Heavy metals are the largest class of contaminants and also most difficult to treat. Lead pollution impacts all the systems of the human body. Many of the methods utilized to remove lead from west water. In the present study attempts have been made to use Tamarindous indica seeds powder (200 mesh size) for the removal of Pb (II) ion from waste water and industrial effluents. The air dried powder of Tamarindous indica seeds act as phenol formaldehyde resin. The experimental adsorbent material is economically feasible and easily available. In present investigation the phenol formaldehyde resin prepared from Tamarindous indica seeds .It has been used as the adsorbent and carried out batch mode experiments to study the effects of contact time and pH on the removal of lead with the variation of dose of the adsorbent. The Pb (II) *adsorbed in presence of 1% PAR at pH 6.5.It shows 100% adsorption on 5 gm resin at 20 min. The paper also discusses the applicability of adsorption isotherm.*

Keyword: Low cost adsorbents, lead, adsorption, wastewater, effluents and isotherm.

INTRODUCTION

Many toxic heavy metals have been discharged in to the environment as industrial waste causing serious soil and water pollution[1].The heavy metals including cobalt , copper, iron ,lead , manganese , molybdenum , vanadium , strontium and zinc are needed in trace amount for living organism but beyond limits they are damaging the organism , causing numerous diseases and disorders such as nephritis, scaring ,damage of liver ,brain ,nervous and reproductive system , shrinking of kidney tissues, pre-mature loss of teeth and demineralization of blood[2]. Lead and its compounds is one of the most important industrial health hazards. It causes poisonous effects and toxicity of lead is not left immidetly. It remain in bones of organism for several years .Numerous process exist for removing dissolved heavy metals are ultra filtration ,reverse osmosis , electrolysis solvent extraction ,ion exchange chromatography , but these methods have some short comings and require large time [3]. Industrial waste water are mostly loaded with heavy

metals that are not biodegradable and leads to accumulate in to aquatic organism. In order to decrease the content of heavy metals in the environment . It is necessary to treat waste water before its discharge. The most commonly used treatments are oxidation/reduction and neutralization followed by chemical precipitation [4]. These treatments do not usually ensure removal up to allowed concentration, for complete removal the suitable process such as adsorption, ion exchange, membrane techniques [5]. Various researchers used plant material as adsorbents includes tea waste, coffee, cotton waste , pulp nutshell, peat, moss, sea weeds, coconut husk, bagasse , rice hull, modified cellulosic materials, plant skins, algae bark, modified bark, plant biomass and bituminous coal[6]. Activated carbon is microcrystalline, non graphitic forms of carbon with porous structures that has been processed to develope its internal porosity. The use of commercial activated carbon is well known adsorbent for the removal of heavy metal from water and waste water. The high cost of activated carbon limits its use as an adsorbent in developing countries hence it is a growing need to derive the low cost resin for the removal of heavy metals [7]. Another naturally occurring substances are used for removal of various heavy metals. These are known as zeolites and act as best ion exchanger [8].The zeolites are costly, toxic and rarely available. Several other adsorbent like discarded automotive tires, human hairs, starch xanthate and oxides of manganese are used but they are not easily and widely available [9]. Pollution is the most widely valuable problem in modern world. The most dangerous type of pollution is water pollution. Pb (II) is very toxic metal present in the industrial effluent act as the major source of pollution. Many methods are suggested for the removal of such toxic metal from aqueous solution. The most useful and economic method is adsorption. Removal of such toxic heavy metal is done by naturally occuring adsorbent like tea leaves, cotton capsule shell, bajara hull, moong shell, Bidi leaves, saw dust, paddy husk[10].

Tamarindous indica seeds powder are easily available, low cost eco friendly ion exchange resin. It is used in the form of phenol formaldehyde resin for removal of toxic heavy elements from aqueous solution.

In present study Langmuir and freundlich adsorption isotherm were also employed to determine the adsorption capacity of the adsorbent for the removal of Pb (II) ions.

MATERIALS AND METHODS

Plant profile:
Botnical classification of Tamarindous indica

KINGDOM	PLANTAE
DIVISION	MAGNOLIPHYTA
CLASS	MAGNOLIPSIDA
ORDER	FIBULAS
FAMILY	FABACCEAE
SUBFAMILY	CAESALPINIOIDEAE
TRIBE	DETARIEAE
GENUS	TAMARINOUDS
SPECIES	INDICA.

Preparation of resin:
The 5 kg of seeds of Tamarindous indica was pulverized after drying it in sun light in open air for one week. Small size piece of dried seed has been grinded for 200 mesh powder. This powder is treated with 39% formaldehyde and 0.2N. Sulphuric acid at 80°c, for half an hour, after cooling and washing with double distilled water substrate allow to dry for overnight in open air. Dried powder is used for adsorption studies[11].

Scheme : Seed powder ⟶ formaldehyde 700ml ⟶ 0.2N sulphuric acid 10 ml ⟶ heat for half hour at 80°c ⟶ cool substrate ⟶ filter substrate ⟶ wash with double distilled water ⟶ dried at open air use this substrate as insoluble ion exchange resin.

Phenol Formaldehyde Resin: this resin is also called Navioc resin. Chemical reaction occurs during formation of resin is as follows. Seed contain polyphenols when these are treated with formaldehyde and sulphuric acid then phenol-formaldehyde resin formed which acts as ion exchanger.

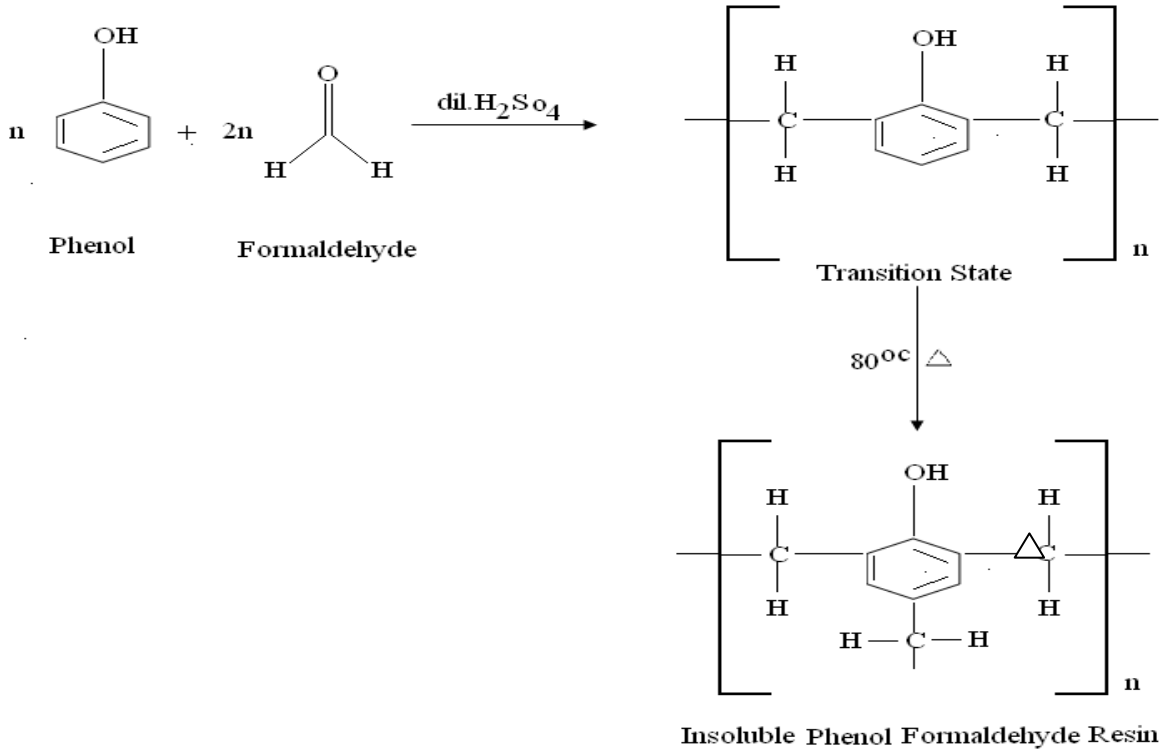
Experimental

Instrumentation-

- A spectrometer Ellico SL-159 was used.
- Equiptronic digital PH meter was used for measurement of PH.

Reagents: All chemical were used of analytical grade .The experiment were conducted with aqueous solution of lead prepared by dissolving 1.463 mg of lead sulphate in one liter of double distilled water.

1% PAR 4(2-pyridylazo) resorcinol is prepared by dissolving 1 gm of PAR in 100 ml of double distilled water [12].



RESULTS AND DISSCUTION

Table no. 1. presents the comparative value of characteristics of resin. It is found from table1 that bulk density for resin is 0.15 gm/cc. the other physico-chemical characteristics like ash

content, matter soluble in water and acid, moisture content and water holding capacity are suggested [13].

Table -1 characteristics properties of the ion exchange resin

CHARACTERISTICS	PROPERTIES
Physical form	Spherical
Bulk density	0.15 gm/cm^3
Ash content	10.4 %
Moisture content	8.7 %
Matter soluble in water	8.4 %
Matter soluble in acid	18 %
Water holding capacity	80.32 %

Effect of contact time:

It is observed that Tamarindous indica seeds act as a low cost adsorbent works effectively. The maximum time required for adsorption is 20 min for 100% removal of Pb(II) at 5 gram resin. After which the amount adsorbed remain virtually constant. The removal curve was found smooth and indicating the formation of mono layer coverage of adsorbent [14].

Effect of pH.:

The powder of Tamarindous indica seeds is effective adsorbent for the removal of pb (II) from aqueous solution at pH 6.5,with increases in pH adsorption decreases. This may be due to decrease in negative charge on the adsorbate [15].

Adsorption isotherm:

To study the validity of Freundlich and Langmuir adsorption isotherm the following equation was used.

$$X/M = KC^{1/N}$$

The linear plot of log of X/M vs. log C indicates the applicability of Freundlich and Langmuir adsorption isotherm. This show the system, which exist with monolayer coverage of the adsorbent on the adsorbate. To verify Freundlich and Langmuir adsorption isotherm. I/Ce is plotted against 1/q.

Table 2 Adsorption capacities of Tamarindous indica seeds (Initial conc. = 3.5mg/ml)

Mass of adsorbent mg.	Conc. Ce mg/ml.	Log. Ce	X=Co-Ce	X/M	Log. X/M	Ce/X/M
250	3.1	0.4914	0.4	1.6	0.2041	1.9
300	2.9	0.4624	0.6	2.0	0.3010	1.5
350	2.7	0.4314	0.8	2.2	0.3424	1.2
400	2.5	0.3979	1.0	2.5	0.3979	1.0
450	2.0	0.3010	1.5	3.3	0.5185	0.61

Freundlich and Langmuir adsorption parameters are very useful in predicting adsorption capacities and also for incorporating a mass transfer relationship. The isotherm can be written as

$$Ce/Qe = 1/KL + QL/KL .Ce$$

Ce is the concentration of adsorb ate at equilibrium ,Qe is amount of ions adsorbed per unit weight of adsorbent, QL and KL are Langmuir constant. The plot of log of Qe – Q vs. t is straight line [16].

Table 3 Effect of contact time.

Time (min)	√t	Ce	q = Co-Ce	Ce-q	Log Ce-q
10	3.2	3.1	0.4	2.7	0.4314
20	4.5	2.9	0.6	2.3	0.3617
30	5.5	2.7	0.8	1.9	0.2788
40	6.3	2.5	1.0	1.5	0.1761
50	7.1	2.0	1.5	0.5	0.6990

Table 4 conc. of Pb (II) from water sample before resin treatment.

Sample site	Pb (II)solution + Reagent (ml)	PH	O.D	Conc. (mg/ml)
1	25	6.5	0.10	6
2	25	6.5	0.10	6
3	25	6.5	0.12	8
4	25	6.5	0.08	4
5	25	6.5	0.05	1

Table no. 5 Concentration of Pb (II) from water sample after resin treatment.

Sample site	Pb (II)solutn (ml)	Resin (gm)	Time (min).	PH	O.D	Conc. (mg/ml)	% removal
1	25	5.0	20	6.5	0.01	0.2	96.7
2	25	5.0	20	6.5	0.01	0.2	96.7
3	25	5.0	20	6.5	0.00	0.4	95
4	25	5.0	20	6.5	0.00	0.00	100
5	25	5.0	20	6.5	0.00	0.00	100

Table no . 6 Conc. of Pb (II) from industrial effluent before resin treatment.

Name of industry	Effluent reagent (ml)	PH	O.D	conc. (mg/ml)
Cipla-1	25	6.5	0.064	2.4
Cipla-2	25	6.5	0.079	2.9
Task chem.	25	6.5	0.079	2.9
Emcure	25	6.5	0.07	3.0
Glen mark	25	6.5	0.066	2.6

Table no. 7 Conc. Of Pb (II) from industrial effluent after resin treatment

Name of industry	Effluent (ml)	Resin (gm)	Time (min)	PH	O.D	conc. (mg/ml)	% Removal
Cipla-1	25	5.0	20	6.5	N.D.	ND	100
Cipla-2	25	5.0	20	6.5	0.03	0.6	79.31
Task chem.	25	5.0	20	6.5	0.03	0.6	79.31
Emcure	25	5.0	20	6.5	0.03	0.6	80
Glen mark	25	5.0	20	6.5	0.01	0.2	92.2

fig 1
Langmiur Adsorption Isotherm

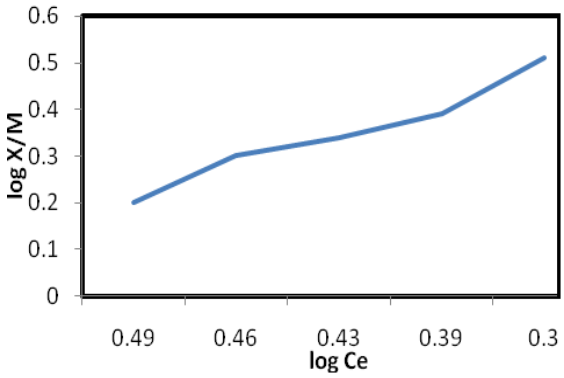


fig 2
Effect Of pH

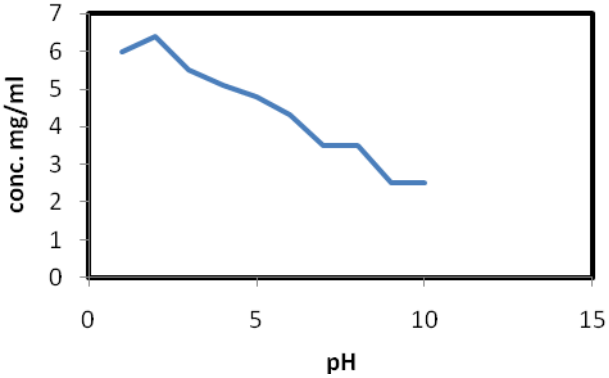


fig 3
For Water Sample

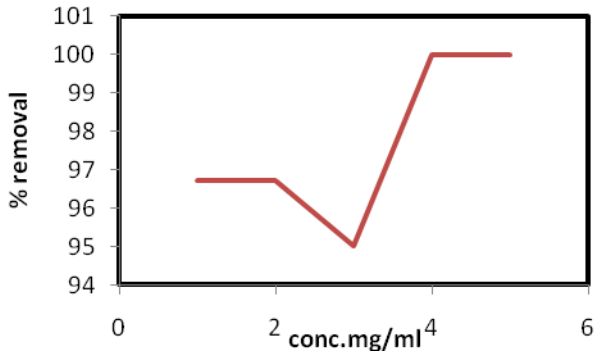


fig 4
% Removal of Effluent

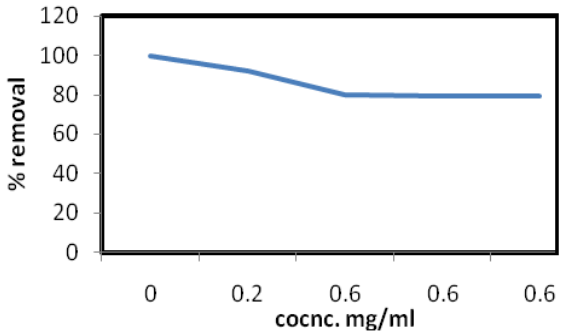


fig 5
Larergen Plot

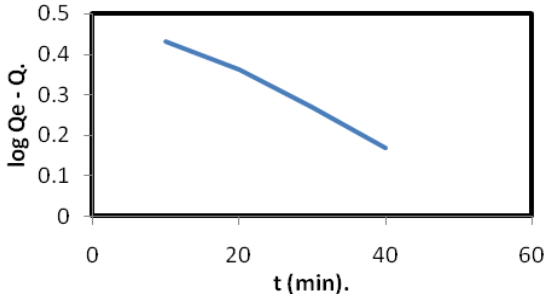
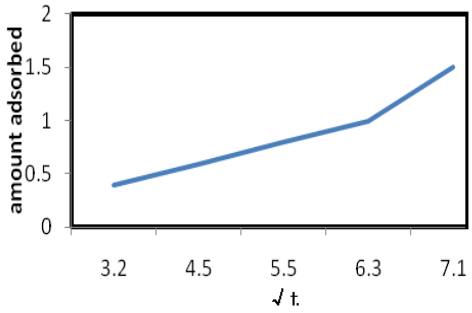


fig 6
plot of amount adsorbed against √t



CONCLUSION

It is found from the characterization study the selected adsorbent Tamarindous indica seeds is expected to have more adsorptive capacity and hence it act as a suitable adsorbent for the removal of pb (II) ion from aqueous solution of lead sulphate. The adsorption data suggest that the pH of the solution is the most important parameters in the control of metal ion adsorption on the adsorbent. This study shows the ability of the adsorbents to adsorb metal ion only in less acidic medium. Hence the batch mode studies were carried out at pH 6.5. The equilibrium time 20 min. appear to be sufficient for the maximum adsorption of Pb (II) species by Tamarindous indica seeds. The maximum amount of Pb (II) adsorbed is found to be 100%. The percent

removal of Pb (II) from waste water increases with increasing dose of the adsorbent that the minimum time required to achieve maximum adsorption decreases with the increase in the dose of adsorbent. The conclusion derived from the study of applicability of Langmuir and freundlich adsorption isotherm to the present system revaluated the first order kinetics nature of the adsorptive process.

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