IOSR Journal of Applied Chemistry (IOSR-JAC)
e-ISSN: 2278-5736.Volume 9, Issue 2 Ver. II (Feb. 2016), PP 21-27
www.iosrjournals.org

Removal of Zn (II) and Lead (II) ions from aqueous solution by Adsorption on to Tectonagrandise Bark powder

S.Dharmambal[1], N.Mani[2]
PG and Research Department of Chemistry,A.V.V.M.Sri Pushpam college,Poondi-613502.

Abstract: *In this work the adsorption removal of Zn (II) and Pb (II) from aqueous solution on to activated carbon prepared from Tectonagrandis bark powder (TGBP) has been investigated through batch experiment the Pb(II) Zn(II) adsorption fount to be dependent on adsorbent dosage, initial concentration, pH and contact time. All batch experiment carried out to Pb(II) and Zn(II) is 7 PH and at constant Temperature 30°C.using a Magnetic stirrer at one hours in 750rpm,The experiment data fitted to Langmuir and Freundlich isotherm. Adsorption process found to follow first order and second order kinetic model.*

Keywords: *Lead (Pb(II)),Zing(II), Tectonagrandis bark powder(TGBP), Isotherm, kinetics.*

I. Introduction

The processes of ecosystem are increasing with developing technology. Heavy metal pollution is one of the main problems. Toxic metal compounds coming to earth's surface not only reach the earth's water (seas, Lakes, ponds and reservoirs) [1].

Due to the toxicological importance in the ecosystem, agriculture and human health, pollution by heavy metals has received wide spread attention in the recent year [2].

One main concern that requires much attention is the contaminated of heavy metals into our earths aquatic bodies. contemporary industries such as the fertilizer industries, pulp and paper mills. Electroplating operations, mining operation and metal processing plants are the sources of heavy metal pollution .for example copper, Lead, Zinc, chromium, Nickel and Aluminum are hazardous, as they remain toxic even at low concentrations and can accumulate through food chain as they are no biodegradable and cannot be metabolized by the body. Heavy metals are divided in to three groups, which include toxic metals (for ex. cu, Lead, chromium, Ni, etc...) precious metals (for ex palladium, silver, gold, etc...) And radio nuclides (for ex Uranium, Radium, etc…).Toxic metals are considered the most hazardous both in ecological and health concerns [3]. Lead accumulation in the human body has been the major cause of dysfunction of kidney, liver, central nervous system, Anemia, and blood pressure. And Zinc accumulation in the human body leads to electrolyte imbalance, depression and reduced intelligence quotient in children [4].

The adsorption process provides an attractive and alternative treatment especially the adsorbent is in expensive and ready available such as a study of Adsorption of Lead(II) [5],sorption of Cu(II) [6] , Nettle ash[7] , Zn adsorption [8] , Rice husk ash[9], Removal of Cr(vI) [10], Cu^{2+} on Rice bran[11], Removal of Cu(II) and Ni(II) [12].

This paper studies two sorption systems. Lead and Zinc by Tectonagrandis bark powder. The isotherm constants for the Langmuir, Freundlich and pseudo kinetic models, batch sorption studies have been determined.

II. Materials and method

2.1 Preparation of Tectonagrandis bark powder

The present study on activated carbon prepared from the Tectonagrandis bark powder by ®reatment for carbonization. This step carried out at 500°C for 2 hours in muffle furnace, after the carbon was removed and washed in distilled water again and again so that external of acid can be removed and the carbon is dried in 200°C in oven for 2 hours. After the carbon is ground and powdered to 75mic size of Tectonagrandis bark powder (TGBP) and stored in plastic container which can be used further study of experiment.

2.2 Preparation of Metal ions Solution

A range of Zinc(II) and Lead(II) stock solution of 1,000mg L^{-1} ,each of standardized Zn(II) and Lead(II) were prepared from $ZnSo_4 .7H_2O$, $Pb(NO_3)_2$.respectively working standard solution of their metal ions were further prepared by serial dilution of the stock solution with double distilled water. All reagent used in the experiment were of analytical grade .Zinc and Lead concentrations were determined using a spectrophotometer.

2.3 Analysis

Metal concentration the total metal concentration in solution was determined with spectrophotometer (spectroquant ®pharo 300) Sr.No 135020367. By marck KGaA Germany.

2.4 Metal uptake

The Zinc (II) and Lead (II) uptake was calculated by the simple concentration and different method. The amount of metal ions in solutions adsorbed(q_e) by Tectonagrandis bark powder (Adsorbent) were calculated from the initial metal ions concentration(C_o)mg/L^{-1} and the equilibrium concentration of metal ions in solution C_i(mg/L^{-1}) using the formula given in equation1*):

$$q_e = V (C_o - C_i) / W \qquad (1)$$

V is the volume of the solution (L) and W is the dry mass of the Tectonagrandis bark powder used (g).

III. Batch adsorption studies

3.1 Effect of dose

The effect of dosage was investigated by agitating weighted of Tectonagrandis bark powder. taken from 10 to 50mg with 50ml/L of metal ion solutions at pH 7 for 1 hour on magnetic stirrer. The mixtures were than filtered. The metal ions concentrations in the filtrated were determined by spectrophotometer.

3.2 Effect of initial pH

Metal ions standards of different pH ranging from 3 to 9 were prepared by adjusting the PH of 0.01N Hcl and NaOH solution. A weighted amount of TGBP 50mg/L was gently agitated with 50ml of metal solution for 1 hour on magnetic stirrer. Samples were immediately filtered through No.1 paper these solutions were determined using spectrophotometer.

3.3 Effect of contact time

The effect of contact time was investigated by agitating 50mg/50ml each of metal ions standards at pH 7.for time intervals of 10 to 60 minutes. On magnetic stirrer and the mixtures were filtered at the end of each time interval. And the metal ions concentrations were determined using in spectrophotometer.

IV. Results and discussion

The adsorption of Zinc (II) and Lead (II) ions on TGBP was investigated as a function of dosage, initial PH, contact time. This studies of TGBP for the Zinc and Lead removal using the experiment equilibrium data for Langmuir and Freundlich adsorption isotherm was calculated.

4.1 Effect of Dosage

The effect of adsorbent dosage in removal of Zinc (II) and Lead (II) shows in fig (1) and (2).The dosage increased from 10 to 60mg resulting increasing from Lead 81% to84% and Zinc is 62% to 69%. These increasing in the sorption of the amount of metal ions are obvious due to increasing sorbent surface area and number of binding sites for ions.

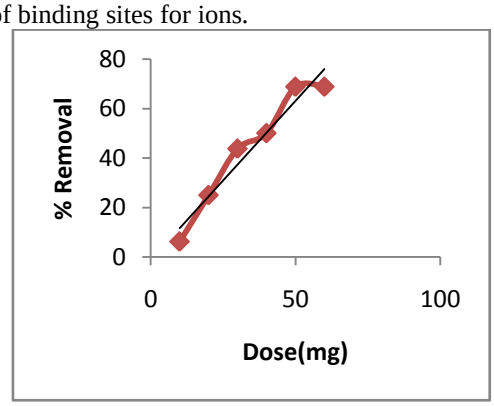


Fig (1)

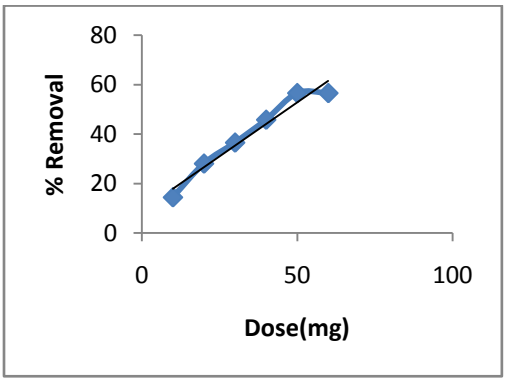


Fig (2)

Fig (1) & (2) Effect of dosage on the adsorption of Pb(II) and Zn(II)

4.2 Effect of pH

The sorption of Pb (II) and Zinc (II) by Tectonagrandis bark powder increased with increase in pH from 3 to 7. The initial concentration was (Pb =10ppm and Zn=20ppm). Resulting shows fig (3,4) sorption highly deponent on pH and the increase with increasing in pH maximum removal Zn (II) and Pb(II) is recorded at 5pH .on farther increase in pH adsorption decreased. Adsorption sides of metal ions due to the formation of metal hydroxide.

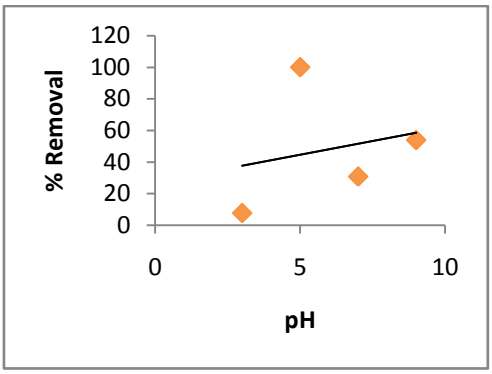


Fig (3)

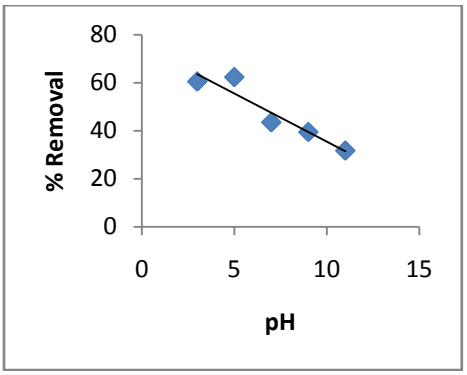


Fig (4)

Fig(3) &(4) Effect of pH on the adsorption of Pb(II) and Zn(II)

4.3 Effect of contact time

The effect of contact time for Zinc (II) and Lead (II) was measured at given contact time for three different initial concentrations from Pb (II) 10 to 30 mg/L and Zn (II) 20 to 60 mg/L. from fig (5). The plotted with percentage removal and time. The maximum amount of metal removed was attained after about 50 min further increasing contact time increased in Lead (II) and Zinc (II) adsorption and it remains contact after equilibrium reached in 60 min for various initial concentration.

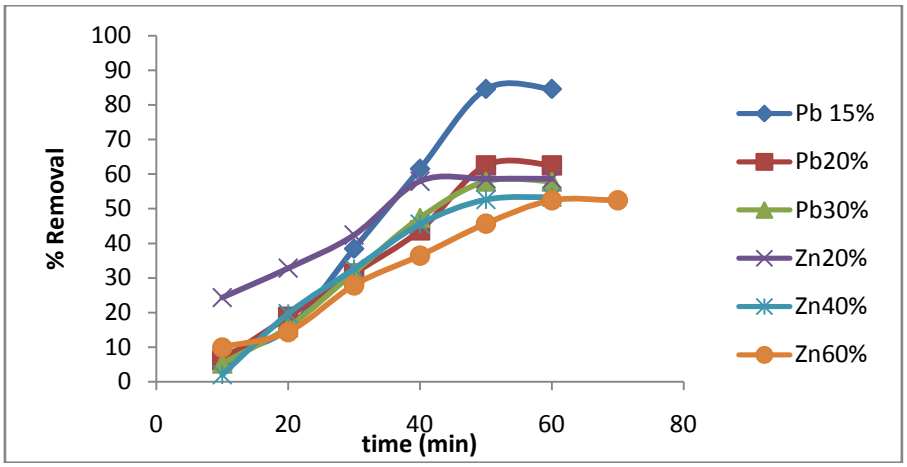


Fig (5) Effect of contact Time on adsorption of the Pb (II) and Zn (II) on TGBP
pH =5,50mg/50mL.

V. Equilibrium study

Adsorption equilibrium studies understood the behavior of adsorbent at an equilibrium condition. Adsorption isotherms are mathematical distribution of the adsorbate species among liquid and solid adsorbent. Based on a set of assumption that are main related to homogeneity and heterogeneity of adsorbent adsorption data are usually described by adsorption isotherm such as Langmuirm and Freundlich model uptake per unit mass of adsorbent q_e to the adsorption equilibrium concentration in fluid phase C_e.

5.1 Langmuir isotherm

The Langmuir isotherm model was used to describe observed sorption phenomena and suggested that uptake occurs on a homogeneous surface by monolayer sorption of Zinc (II) and Lead (II) ions on the surface of carbon sides and can be explained in Linear form(2):

$$C_e / Q_e = 1/ Q_0 b + C_e / Q_0 \qquad (2)$$

Where is the equilibrium concentration ($mg.L^{-1}$), Q_e is the amount adsorbed at equilibrium ($mg.g^{-1}$), Q_0 ($mg.g^{-1}$) and b(mg^{-1}) are Langmuir constant related to maximum adsorption capacity and energy of adsorption respectively. A plot of C_e/q_e and C_e should indicate give slightly straight line slop $1/Q_0$ and intercept $1/Q_0b$.shows figs (6,7). The adsorption of Zn (II) and Lead (II) onto TGBP followed Langmuir isotherm apply the Linear form of correlation co-efficient R^2 = 0.997 and R^2= 0.995 model the value of q_0 and b were determined from the Langmuir plot and listed in table (1).

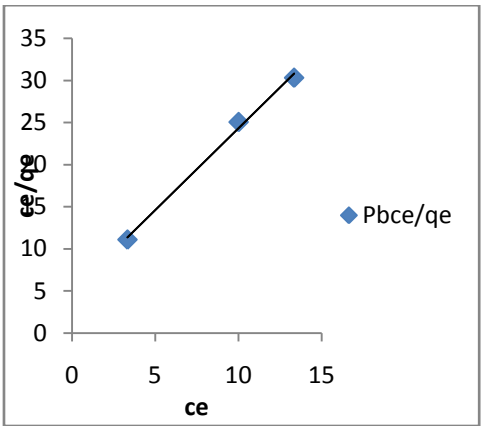


Fig (6) Langmuir isotherm plot for the adsorption of metal Pb(II) on TGBP (50mg/50ml, pH=5)

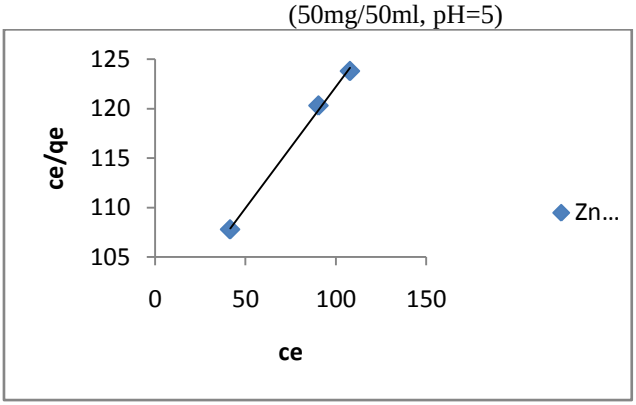


Fig (7) Langmuir isotherm plot for the adsorption of matel Zn (II) on TGBP (50mg/50mL ,pH=5)

5.2 Freundlich isotherm

The Freundlich isotherm is applicable to non-ideal adsorption of heterogeneous surface and the linear form of the isotherm can be respected as (3):

$$Log\ q_e = \log k_f + 1/n \log C_e \qquad (3)$$

The k_f is Freundlich constant related to sorption capacity (mg/g) $(L/g)^{1/n}$ and the adsorption intensity of the adsorbent. k_f and n can be determined from the linear plot of log q_e versus log C_e. The present studies of Lead (II) and Zinc (II) conducted to 120 mints with 50mg/50ml at pH 5, and different concentration ranging to Pb(II) 10 to 30 ppm and Zn(II) 20,40, 60 ppm respectively. The intercept slops Linear plot of log q_e Vs log C_e resulting the adsorption process was investigated by correlation co-efficient R^2= 0.959, 0.931 . The values of K_f and n given in the table (1) shows that the data can be determined Langmuir and Freundlich is best fit for the isotherm.

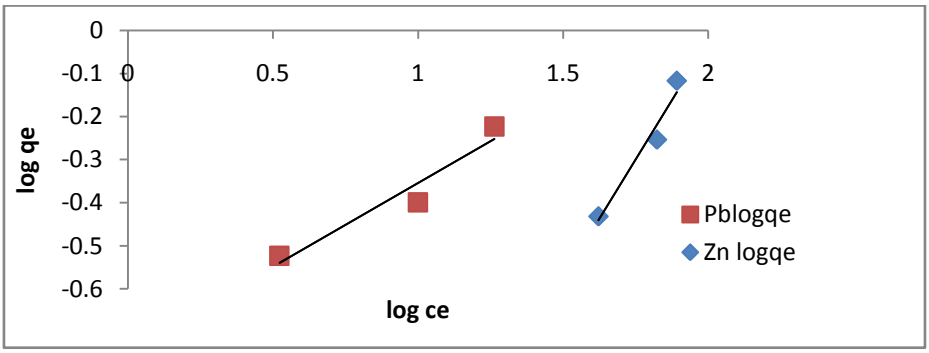


Fig (7) Freundlich isotherm plot for the adsorption of metals Pb(II) and Zn(II) on TGBP Dose (50mg/50ml, pH=5)

Table 1 Langmuir and Freundlich adsorption isotherm constant for Zn (II) and Pb (II) on TGBP

Langmuir model	Zn	Pb	Freundlich model	Zn	Pb
Q_0(mg/g) =	4.098	0.51	n =	0.91	2.58
b =	0.010	0.20	K_f =	2.86	0.76
R^2 =	0.997	0.995	R^2 =	0.959	0.931

VI. Kinetic study

The kinetic study was carried out to determine the equilibrium time required for the uptake of metals in Zn (II) and Pb (II) from the aqueous solution. This experiment can provide information about mechanism of the reaction between adsorbent and adsorbate. This is good useful to understand adsorption process. This model can be suggested for an adsorption including pseudo first order and second order linear as below.

6.1 pseudo first order

In order to defined the adsorption kinetics of heavy metal ions. The Lagergren first order rate equation is given as (4):

$$log\ (q_e\text{-}q_t) = \log q_e - (kt) / 2.303 \qquad (4)$$

Where q_e and q_t are amount of Zn and Pb adsorbed (mg/g) at equilibrium time t respectively and k_t is rate constant. The pseudo first order adsorption process (min^{-1}).values of q_e and k at different initial concentration were calculated from the slop and intercept of the plots log (q_e-q_t) versus Time (t).show the fig (8).

This experiment were performed at the initial Pb(II) and Zn(II) concentration of 50ml/L and at room temperature respectively. The result of metal adsorption kinetic experiment shows in fig (8, 9). The slops were taken from the intercept of plot of log (q_e-q_t) and time. It is determined the first order rate constant k and equilibrium adsorption density q_e noted table (2) for different concentration of Zn (II) and Pb (II) metals (Pb=15,20,30 and Zn 20,40,60 ppm on Tectonagrandis bark powder).

The comparison of results with correlation co efficient is shows Table (1).The R^2 is approximately range (Zn=0.957, 0.998, Pb=0.989, 0.976, 0.953) .The theoretical q_e values obtained from pseudo first order kinetic modal to give reasonable values. The suggested that this range adsorption system in first order reaction.

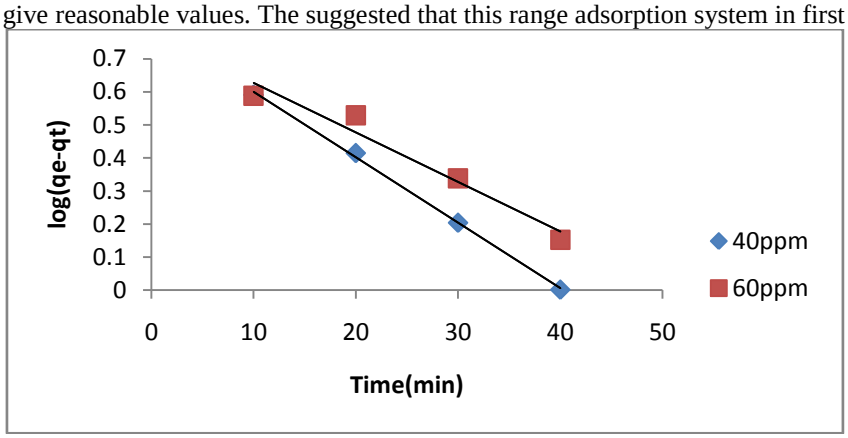


Fig (8)

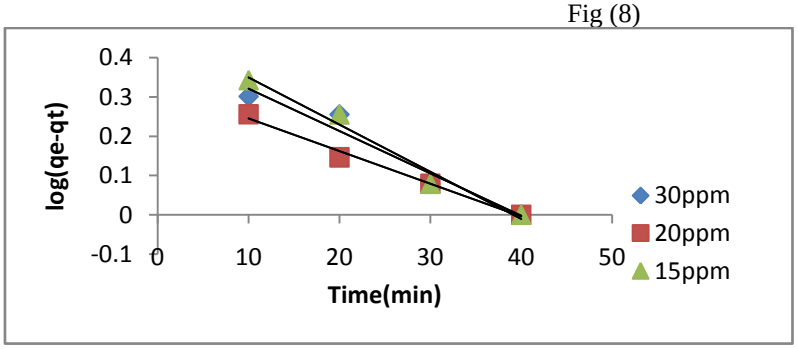


Fig (9)

Fig (8, 9) pseudo first order for Pb (II) and Zn (II) on TGBP

Table (2) Kinetic parameters of the pseudo first order for the Zn (II) and Pb (II) adsorption

Initial metals concentration(ppm)	K_1 values min^{-1}(× 10^{-3})	R^2 values
Zn		
40	0.70	0.998
60	0.33	0.957
Pb		
15	0.86	0.976

20	0.65	0.989
30	0.52	0.953

6.2 Ho' s pseudo second order

The pseudo second order kinetic model which is based on assumption is the rate determining step can be expressed as (5):

$$t/q_t = 1/k\ q_e^2 + t/q_e \qquad (5)$$

Where k_2 is pseudo second order rate constant ($gmg^{-1}min^{-1}$). Q_e and q_t represent the amount of metal adsorbed (mg/g) at equilibrium and at Time t. for the condition t=0 to t=t and q_t=0 to q_t= q_t, the integral form of equation becomes (6):

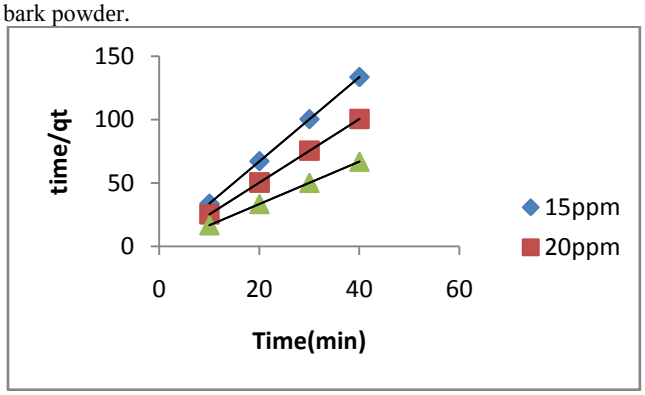
$$q_t = t/k_2 q_e + q_e$$

$$t/q_t = 1/K_2 q_e^2 + t/q_e \qquad (6)$$

The constant K_2 was used to calculated the initial sorption rate h, at t=0 as follows (7):

$$h = K_2 q_e^2 \qquad (7)$$

Straight line for pseudo second order model was obtained and it indicates the applicability of this kinetic model. The second order rate constant k_2 values were calculated from the slop of the line in fig (10, 11). The pseudo second order reaction rate model adequately described the kinetic of model adsorption with high correlation co efficient for all range of metal concentration. The best result obtained from the second order kinetic model obtained in 1. The q_e values are also very well with the experiment data these results indicate the adsorption of system studied belongs to the pseudo second order kinetic model. The respective values are given in table (3). The similar phenomena are also observed in adsorption of Zn (II) and Pb (II) metal on Tectonagrandis bark powder.



Fig(10) Pb(II)

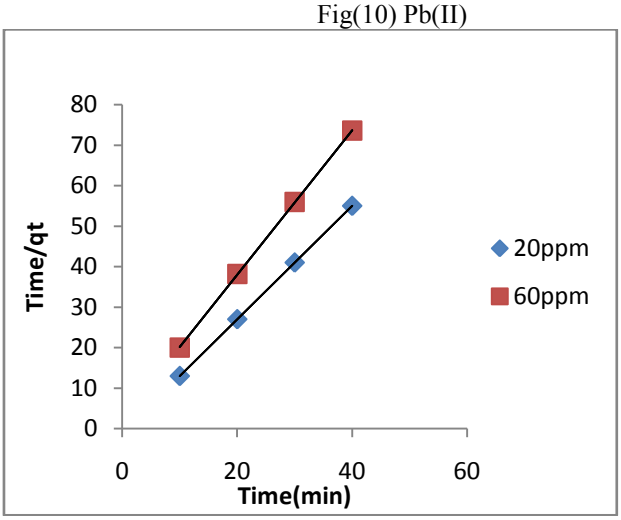


Fig (11) Zn(II)

Fig(10 ,11) Kinetic pseudo second order for Zn(II) and Pb(II) on TGBP

Table (3) Kinetic parameters of the pseudo second-order for the Zn(II) and Pb(II) adsorption

Initial metal concentration(ppm)	Q_{eq}(exp) (mg/g)	K_2 (min^1) $\times 10^{-3}$	h (mg /g^{-1}) (min^{-1})	R^2
Zn				
20ppm	0.56	0.56	1.0	1
60ppm	0.70	0.32	0.43	1
Pb				
15ppm	0.30	0.24	0.23	1
20ppm	0.39	0.26	0.86	1
30ppm	0.60	0.17	0.16	1

VII. Conclusion

The result obtained from the present study investigation is helpful to Zn(II) and Pb(II) onto Tectonagrandis bark powder. The studies were followed as adsorbent data. Contact time, pH .and various dosages the amount of metal removed was found to increase with increase time and adsorbent dose maximum adsorption occurs in pH 5.Removal percentage low at Zn (II) at 58% and Pb (II) is maximum amount removed 87% .The equilibrium studies to give both Langmuir and Freundlich model can be best fit for both metal adsorption equilibrium data. The adsorption kinetic studies as followed as pseudo first order and second order model was using concentration range Zn(II) is 20,40,60 ppm and Pb (II) is 15,20,30 mg/L. The present studies conclude that Zn (II) and Pb (II) could employ as adsorbent of Tectonagrandis bark powder.

References

[1] Hengpeng Ye*, Zhijuan Yu,adsorption of Pb(II) on to modified Rice Bran Natural Resourus,2010,1,104- 109.

[2] Sarita, R.N.pandey, Upapati, M.K.Mishra and K.K.Sign.Adsorption of Cu(II), Pb(II), and Zn(II), from highway runoff using agricultural byproduct ricebran. J Chem.pharm, Res.2011:2(2): 354-364.

[3] V.S.Sethu*,Y.L.Kuk, Adsorption Thermodynamics of Cu(II)ions from wast water using Neem Leaf based biosorbent.Journalof Environment Research and Development Vol.6, No1, July sep 2011.

[4] O.J.Oshodi, A,A.& Enahoro P.O. Adsorption Eqilibrium study of Lead and Zinc on Rice Husk from aques solution. Global Journal of Science Frontier Research:B Chemistry Voli 15,Issue 1, Version 1.0 Year 2015.

[5] P.Senthilkumar R.Gayathri Adsorption of Pb^{2+}ions from aqueous solution on to Beal Leaf powder: isotherm kinetic and thermodynamic study.Journal of Engineeringscience and Technology Vol.4, No,4(2009) 381-399.

[6] P.king ,P.Srinivas Y.Prasanna kumar* sorption of Copper(II) ion from aqueous solution by Tectonageandis L,f(teak Leaves poeder). 0304-38941-see front mater©Elsevier, B,V.All right reserved doi;1016.j.j hazmat 2005.

[7] H.Zavvar Mausari: S.R.Seyedi Nettle ash as a low cast adsorbent for the removal of Ni and cadmium from wast water.Int.J.Environ.Sci-Tech,8(1),195-202,Winter 2011.

[8] Nilgum Balkaya and Hasan Cesur, Zinc adsorption kinetic by phosphogypsum-A preliminary study.Journal of Scientific & Industrial Research Vol.67, March 2008,pp. 254-256.

[9] CH.Sekhararao Gulipalli, B.prasad, Kailas L.Wasewar* .Batch study.equilibrium and kinetic of adsorption of selenium using Rice husk ash(RHA).Journal of Engineering Science and Tecnology.Vol 6, No.5(2011) ,586-605.

[10] A.K.Bhattacharya S.N.Mandal & S.K.Das.Removal of Cr(vI) from aqueous solution by adsorption onto Low cast non-conventional adsorbent.Indian Journal of Chemical Technology Vol.13, Nov-2006.pp 576-583.

[11] Xue-Song Wang,Youg Qin. Equilibrium sorption isotherm for Cu^{2+}on rice bran. Elsevier process Biochemistry 40(2005) pp,677-680.

[12] B.D.Ghade .Removal of Cu(II) and Ni(II) from aqueous solution using Tectonagrandis bark substrate. Oriental Journal of Chemistry. Vol.26(1), 175-180(2010).