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Studies On Removal Efficiency Of Adsorbent For Lead From Aqueous Solution

R. S. Awachat* R. U. Khope*
Department of Chemistry, Shivaji Science College, Congress Nagar-440012 (M.S.) India
e-mail- khopeyru@gmail.com, awachat21@gmail.com

ABSTRACT:
The effective removal of Pb^{2+} from aqueous solution using filtrasorb 300 (F-300) and filtrasorb 816 (F-816) in presence of phenyl hydrazine hydrochloride was studied. In batch adsorption experiments temperature of 25 ± 1 °C and pH 6 were kept constant. The maximum contact time for the equilibrium condition was 300 min and optimum granular activated carbon dose was 0.5g. the experimental data clearly demonstrated that Granular Activated Carbon (GAC) can be used as a suitable adsorbent for the removal of Pb^{2+} ions from aqueous solution.
Keywords: Adsorption, Lead, Granular Activated Carbon (GAC), Filtrasorb 300 (F-300) Filtrasorb 816 (F-816), Phenyl hydrazine hydrochloride.

INTRODUCTION

In many industrialized countries wastewater is directly discharged into waterbodies leading to serious environmental problems. The heavy metals such as lead, copper, chromium, zinc, nickel, mercury are the most common pollutants found in industrial effluents. These toxic metals can cause poisoning, cancer, and brain damage when found above the tolerance levels [1]. Lead is one of the industrial pollutants. The presence of Lead in drinking water above the permissible limit may cause hazardous effect on human health. Lead damages central nervous system , kidney, liver and reproductive system [2-3]. In children, lead causes a decrease in intelligent quotient (IQ) score, retardation of physical growth, hearing impairment, impaired learning, as well as decreased attention and classroom performance [4].Removal of toxic metals from industrial wastewater is achieved by using many conventional metals such as precipitation, electroplating, chemical coagulation, ion-exchange, reverse osmosis. However these methods are costly and create waste disposal problems [5-9]. Activated carbon is one of the most popular adsorbent for the removal of metal ions from aqueous solutions [10]. In industry area, adsorption is used as effective purification and separation technique for wastewater treatments [11]

MATERIALS AND METHODS

The Granular Activated Carbon filtrasorb 300 (F-300) and filtrasorb 816 (F-816) gifted by M/s Calgon carbon Corporation Ltd Pittusberg, USA were used as low cost adsorbent for the removal of Pb^{2+}. The selected Carbon were first grinded into appropriate size to get the carbon particles and sieved using a sieve shaker. The particles retaining in between 1400µ-1600µ were collected and used for adsorption study. The sieved GAC particles were thoroughly rinsed several times with hot double distilled water and then dried in an vacuum oven at a temperature of 105°C for 12 hours and placed in a desiccators containing anhydrous $CaCl_2$ to removal moisture from the carbon. A stock solution of lead ions was prepared by dissolving required quantity of $Pb(NO_3)_2$ (S.D. Fine Chem. Limited) of analytical grade in double distilled water.

A series of solutions of known concentration of lead ions were prepared. Spectrophotometrically, Beer's law standard curve was established for Pb^{2+} using alizarin red (S) method, to estimate residual concentration of Pb^{2+} ions [12].

All the reagents used in this work were of AR grade. A sample of phenyl hydrazine hydrochloride (S.D. Fine Chem. Limited) was purified and recrystallized by standard method. The experimental melting point of phenyl hydrazine hydrochloride was found to be 244.3 °C and compared with literature value. The sample was also characterized through determination of molecular weight by the technique of pH titration against standard NaOH. To study the adsorption isotherm, 200 ml of 0.001 M solution of phenyl hydrazine hydrochloride, agitated with 0.5 g of GAC in stoppered reagent bottles of 300 ml capacity. It was then shaken for about five hours using Teflon bladed stirrer at about 500 rpm. After five hours the solution was decanted and the carbon particles were washed thoroughly with double distilled water which labeled as loaded carbon. This loaded carbon was then transferred to same reagent bottle and then 200 ml of Pb^{2+} solution at a pH = 6 were added to it. The contents were agitated for 5 hours in a thermostat at a constant temperature of 25 ± 1°C. The initial and final concentrations of the Pb^{2+} ion in mg/L was then analysed by measuring absorbance at 485 nm spectrophotometrically (Chemito spectrascan UV 2700 Double beam UV Visible spectrophotometer). The same procedure was repeated twicely to check reproducible results.

RESULTS AND DISCUSSION

Both Langmuir and Freundlich isotherms were studied in present work. The adsorption isotherm describes the relationship between the liquid phase concentration and surface concentration of adsorbate at equilibrium. The amount of Pb^{2+} on the ligand loaded GAC was estimated using the equation

$$q_e = (C_o - Ce) \times \frac{V}{W}$$

..... (1)

Where,

q_e = Concentration of Pb^{2+} ion on the ligand loaded GAC in mg/millimoles of ligand,

C_o = Initial concentration of Pb^{2+} ion in solution in mg/L,

C_e = Final concentration of Pb^{2+} ion in solution in mg/L,

V = Volume of solution in liters,

W= Millimoles of the ligand actually present on GAC (0.5 g).

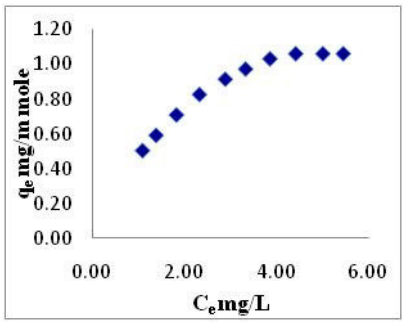

Fig.1. Adsorption isotherm
System: F-300- Phenyl Hydrazine Hydrochlorid-Pb^{2+}

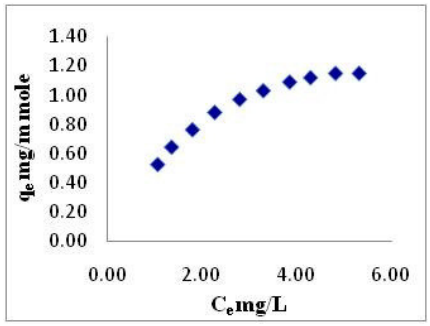

Fig.2.Adsorption isotherm
System: F-816- Phenyl Hydrazine Hydrochloride -Pb^{2+}

The adsorption isotherms of ligand loaded F-300 and F-816 GAC obtained by plotting q_e versus C_e and shown in Fig.1 and Fig. 2. Using values of q_e versus C_e, the Langmuir equation could be expressed as

$$q_e = Q^o b \times \frac{C_e}{(1 + bC_e)}$$

..... (2)

Where,

Q^o = amount adsorbed per unit weight of the adsorbent forming a complex monolayer on the adsorbent surface.

b = Langmuir constant.

Above equation can be linearised

$$\frac{1}{q_e} = \frac{1}{bQ^o} \times \frac{1}{C_e} + \frac{1}{Q^o} \qquad \text{.....(3)}$$

A plot of $1/q_e$ versus $1/Ce$ was found to be fairly linear. Similarly, the Freundlich equation used was

$$q_e = K.C_e^{1/n} \qquad \text{.....(4}$$

Where, k and 1/n are constants determine experimentally. Using equation (4)

$$\log q_e = \log k + \frac{1}{n} \log C_e \qquad \text{.....}$$

(5)

A plot of log q_e versus log C_e fairly showed validity of Freundlich equation over a range of concentrations.

Fig.3 to 6 illustrates the plot of Langmuir and Freundlich isotherms for F-300 and F-816. The plots of $1/q_e$ versus $1/C_e$ were found to be linear indicating the applicability of Langmuir model. The parameters Q^o and b are Langmuir constants relating to the sorption capacity and adsorption energy respectively were determined and reported in Table 1.

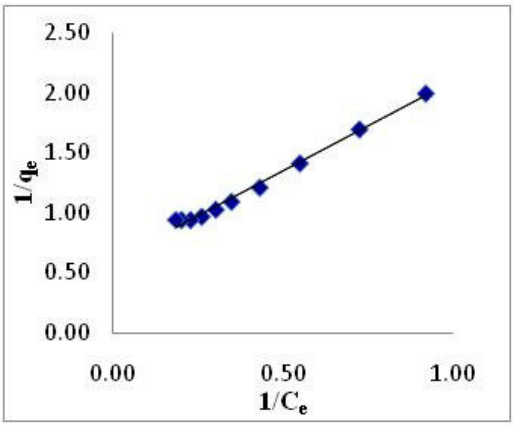

Fig.3 . Langmuir adsorption isotherm
System: F-300- Phenyl Hydrazine Hydrochlorid-Pb^{2+}

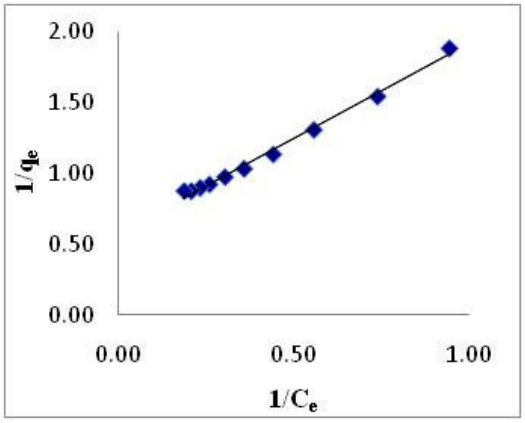

Fig. 4 . Langmuir adsorption isotherm
System: F-816- Phenyl Hydrazine Hydrochlorid-Pb^{2+}

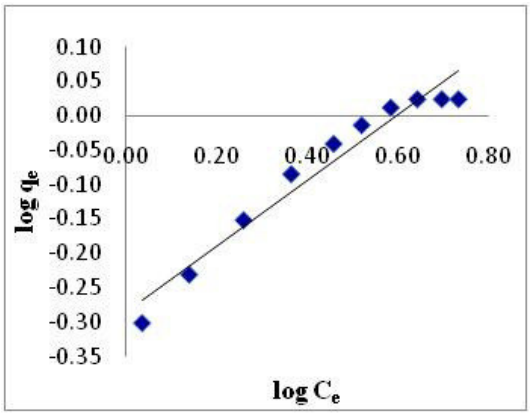

Fig. 5. Freundlich adsorption isotherm
System: F-300- Phenyl Hydrazine Hydrochlorid-Pb^{2+}

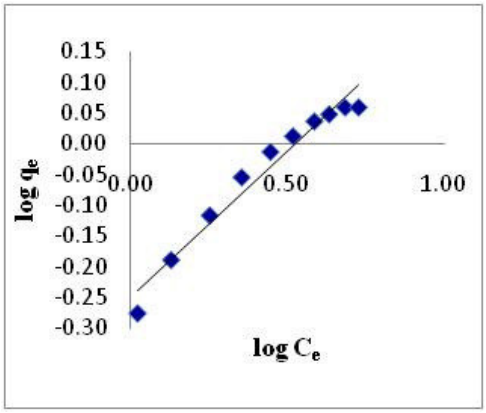

Fig. 6. Freundlich adsorption isotherm
System: F-816- Phenyl Hydrazine Hydrochlorid-Pb^{2+}

Table 1 Langmuir and Freundlich constant and regression correlation coefficient (R^2)

Sr. No.	System	Langmuir Constant and Regression Coefficient R^2			Freundlich Constant and Regression Coefficient R^2		
		Q^o	b	R^2	K_f	1/n	R^2
1	F-300- Phenyl Hydrazine Hydrochloride -Pb^{2+}	1.6409	0.4089	0.992	0.5170	0.4789	0.953
2	F-816- Phenyl Hydrazine Hydrochloride -Pb^{2+}	1.7430	0.4261	0.993	0.5621	0.4749	0.960

The plot of $1/q_e$ versus $1/C_e$ helped in determination of Q^o from which the surface area occupied by Pb^{2+} ion on GAC can be determined. The surface area of the carbon through such Pb^{2+} adsorption can then be represented as

$$S' = Na.Q^o.A \quad \ldots (6)$$

Where,
S = Surface area of adsorbent, cm^2/g,
Na = Avogadro number and
A = Cross-sectional area of the adsorbent molecule, cm^2.

It is possible to determine the surface area of the adsorbent using the technique of adsorbing Pb^{2+} on ligand loaded GAC at the saturation level when a monolayer of the Pb^{2+} would over the entire surface of the adsorbent. Determination of value of S' needed the determination of A the surface area occupied by a single Pb^{2+} ion. The values of A were calculated using the expression given by Brunauer and Emmet.

$$A = 4 \times 0.866 \left[\frac{M}{4\sqrt{2}.Na.d} \right]^{2/3} \quad \ldots\ldots (7)$$

Where,

M = Atomic weight of the Pb^{2+}
Na = The Avogadro number
d = The density of the Pb^{2+},
The values of S obtained from $q_{e\ max}$ S' obtained from Q^o are reported in Table 2

Table 2 Values of Q^O, A, S and S' for a system GAC- Phenyl Hydrazine Hydrochloride -Pb^{2+}

Sr. No.	System	A (cm^2)	$q_{e\ max}$ (mg/m.mol.)	S (cm^2/gm)	Q^0	S' (cm^2/gm)
1	F-300- Phenyl Hydrazine Hydrochloride - Pb^{2+}	1.0539×10^{-15}	1.0588	1.2975×10^3	1.6409	2.0108×10^3
2	F-816- Phenyl Hydrazine Hydrochloride - Pb^{2+}	1.0539×10^{-15}	1.1471	1.4056×10^3	1.7430	2.1359×10^3

This clearly showed the dependence of adsorption on surface area of GAC.

CONCLUSION

Adsorption by granular activated carbon is inexpensive and effective technique for removal of Pb^{2+} from wastewater. In this study, results showed that the adsorption of Pb^{2+} ion performed by GAC was very encouraging. The experimental data seen to be of the favorable type and were then subjected for adherence to both Langmuir and Freundlich adsorption isotherm. All adsorption isotherms of the Pb^{2+} ion on different grades of carbons in presence of Phenyl hydrazine hydrochloride clearly shows that F-816 adsorbs Pb^{2+} ion to a greater proportion as compared to F-300. This is probably due to large surface area of F-816 available for approaching Pb^{2+} ions.

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REFERENCES

Al-Garni S.M., Biosorption of lead by Gram-ve capsulated and non-capsulated bacteria. *Water*,2005, SA 31, 345–50.

Lo W, Chua H, Lam KH, Bi S.P., A comparative investigation on the biosorption of lead by Filamentous fungal biomass. *Chemosphere*,1999, 39, 2723–36.

Fenglian Fu, Wang Qi. Removal of heavy metal ions from wastewater, *Joumal of Environmental Management.*, 2011, 92,407-418.

Okoye A.I., Ejikeme P.M., Onukwuli O.D., Lead removal from wastewater using Fluted Pumpkin seed shell activated carbon Adsorption modeling and kinetics, *Int. J Environ Sci Tech*, 2010, 7(4),793-800.

Sreejalekshmi K.G., Krishnan K.A., Anirudhan T.S., Adsorption of Pb (II) and Pb (II) citric acid on sawdust activated carbon: Kinetic and equilibrium isotherm studies, *Journal of Hazardous Materials*, 2009, 16, 1506 – 1513.

Assadi A, Dehghan, MH, Rastkari N, Nasseri S and Mahvi AH (2012). Photocatalytic reduction of hexavalent chromium in aqueous solution with zinc oxide nanoparticles and hydrogen peroxide. *Environment Protection Engineering*, 38, (4), 5 – 16.

Akbal F and Camcı S (2011). Copper, chromium and nickel removal from metal plating wastewater by electrocoagulation, *Desalination*, 269, (1), 214 – 222.

Khayat Sarkar Z and Khayat Sarkar F (2013). Selective removal of lead (II) ion from wastewater using superparamagnetic monodispersed iron oxide (Fe3O4) nanoparticles as an effective adsorbent. *International Journal of Nanoscience and Nanotechnology*, 9,(2), 109 – 114.

Dehghani MH, Sanaei D, Ali I and Bhatnagar A (2016). Removal of chromium (VI) from aqueous solution using treated waste newspaper as a low-cost adsorbent: Kinetic

modeling and isotherm studies, *Journal of Molecular Liquids*, 215, 671 – 679.

El- Wakil AM, Abou El- Maaty WM, Awad FS. Removal of lead from aqueous solution on activated carbon and modified Activated carbon Prepared from Dried water Hyacinth Plant. *J Anal Bioanal Tech*. 2014, 5,(2).

Nishigandha J Bhakte, Suryavanshi AA. Removal of heavy metal lead (Pb) from electrochemical Induatry wastewater by Adsorption, *International Journal of Advance. Foundation and Research in Science and Engineering*, 2015,(1),261- 265.

Khalaf Faris Alsamarrai. Spectrophotometric Assay of Lead in Human Hair Samples by using alizarin red (S) in Samarra area. *J. of university of Anbar for pure science*, 2011, 5,(3).

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