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Research Article

SORPTION OF TOXIC HEAVY METAL Pb (II) FOR EVALUATION OF KINETIC AND EQUILIBRIUM STUDY USING ADSORBENT SAC

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A B S T R A C T

Toxic heavy metal used and release in environment through water causing serious pollution. Lead ion metal because of its poisonous quality referred to worldwide as it causes some health issues. Expulsion of lead from wastewater is extremely expected to take care of ecological issues through system Adsorption. Batch study was used to know the optimum parameters. Characterization of adsorbent was done by SEM (scanning electron microscope) that reported surface showed lots of cavities available to accommodate adsorbate molecules. Kinetic modeling was expanded by models (Elovich, Bangham and Pseudo Second order) to get the efficiency of adsorbent at 35°C and 45°C. Equilibrium study checked to get the mechanism of adsorption process at room temperature. Temkin adsorption isotherm well fitted as respective to correlation coefficient (R2). All study was performed by using constant magnetic stirrer at a run of 120 min. Lead ion removal percentage maximum upto 77% found in case of pH.

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INTRODUCTION

Harmful Heavy metals adsorption is an essential part of the century. These lethal metals discharges from modern parts and makes condition dirtied. Water contamination turns out to be exceptionally basic point for every single living life form so to influence condition contamination to free in any event from the water utilization important to expel poisonous metal particles.

Pb metal particle is one of the harmful among all even it can take passing of living being if high utilization of this taken in the body. It normally happens even in condition and it's utilized as a part of lead corrosive batteries of autos and furthermore utilized as a part of assembling of channels that essentially utilized for waste frameworks. Lead additionally in charge of kidney and mind harm, unsettling influence in sensory system. It is hazardous for condition to make soil harmed and medical problems [1-7].

As number of adsorbents has been used by researchers upto date, various natural charcoal, sand, wood, plant leaves and manmade adsorbents such as fly ash, activated form of carbon, nanoparticles, polymers, composites, chalk, zeolites, silica gel etc [8-12]. Almost all adsorbents meet the qualities like easy availability, low cost that are prime parameters for any of adsorbent.

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In present study, utilization of sheesam activated carbon (SAC) has shown in term of batch adsorption. Sheesam beans transform into activated form using chemical treatment method. SAC proved as efficient adsorbent for the sorption of pb metal ion.

Table 1 Adsorbents used by past scientists

Adsorbents	References
Chitosan	FC Wu (2010)
Chitosan composites	WSW Ngah (2011)
Nanosized metal oxide	M Hua (2012)
Natural clay	E Padilla-Ortega (2013)
Nanomaterials	WW Tang (2014)
Porous starch	X Ma (2015)
Seasame Starw Biochar	J H Park (2016)
Stipa Tenacissima Leaves	N. Madani (2017)

Experimental
Batch adsorption technique

For batch adsorption operation, prepared known amount of stock solution by mixing desired quantity of lead nitrate salt with distilled water. On handling with room temperature rotary shaker was used with different concentration for a successful operation. With fixed concentration ph vary from 2 to 10 values. For adjustment of pH 0.1 N solution of HCl and 0.1 N solution of H_2SO_4 concentrated 99% used.For isotherm operation, different concentration used with fixed adsorbent quantity at room temperature.

RESULTS AND DISCUSSION

Characterization of Sample

Scanning electron microscope (SEM) is a sort of electron magnifying instrument that produces pictures of an example by checking the surface with an engaged light emission [13-14]. Morphological image of adsorbent presented rough and porous surface that can accommodate more number of adsorbate molecules on its surface. This surface also reported lots of cracks on external surface which is highly favorable for adsorption to occur.

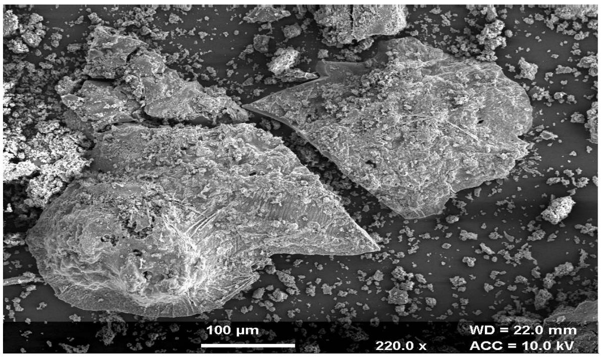

Figure 1 Morphological image of adsorbent

BET Analysis

Brunaeur –Emmett teller (BET) surface area and other parameters presented below.

Micro pore volume	**0.029 cc/g**
Micro pore area	49.561 m²/g
External surface area	117.232 m²/g
Pore volume	0.099 cc/g
Pore diameter	3.340 nm
Surface area	166.794 m²/g

Nitrogen adsorption desorption isotherm was also made up by BET theory. Temperature used was 77 K and pressure 1 bar to find out adsorption desorption points for the sample. This isotherm confirmed the surface of sample which was mesoporous. Mesoporous materials generally adsorbed on surface layer by layer or by force fields acting from the walls side of pore. Hysteresis loop was made from adsorption-desorption of material on the surface at different conditions. Hysteresis loop gave few clear points concerned to porosity of sample.Chemisorptions were responsible for adsorption to occur. Equilibrium condition was defined by equal rate of adsorption and desorption. There was always possibility for the adsorption not on the external surface infact on interior surface also.

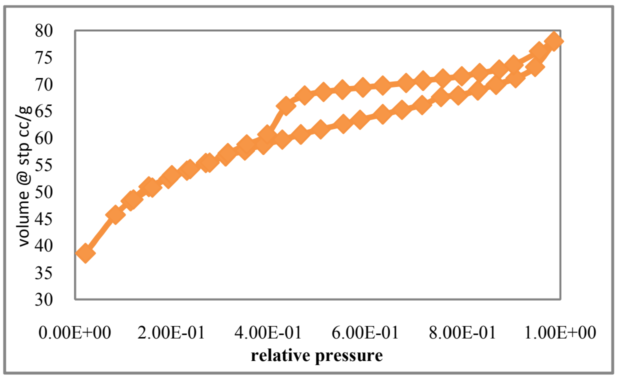

Figure 2 Nitrogen adsorption-desorption isotherm of SAC (77K and

Kinetic Study

To check out the linearity and mechanism adsorption reactions few models are used as pseudo second order, mass transfer diffusion model and elovich first order equation.

Pseudo second order $t/q_t = 1/K_2qe^2+1/q_e\,t$ (1)
Mass transfer diffusion $q_t=Kt^{0.5} + c$ (2)
Elovich model $q_t = 1/\beta \ln \alpha\beta + 1/\beta \ln t$ (3)

Mass transfer diffusion model used to get the rate controlling reaction obtained by film diffusion or pore diffusion. As results speaks up linear line is very close to origin but don’t intersect the origin which confirms adsorption process is not controlled by one step rather multi steps required for diffusion to occur. Linear curve for 35°C and 45°C both showing linearilty with respect to linear coefficient (>>0.9). Some researchers coated similar kind of nature in literature [15].

(Figure 3) Linearity coefficient was calculated with the help of slope and intercept. This kind of behavior well followed by chemisorptions. Similar results obtained for pseudo second order cited in literature [16-19]

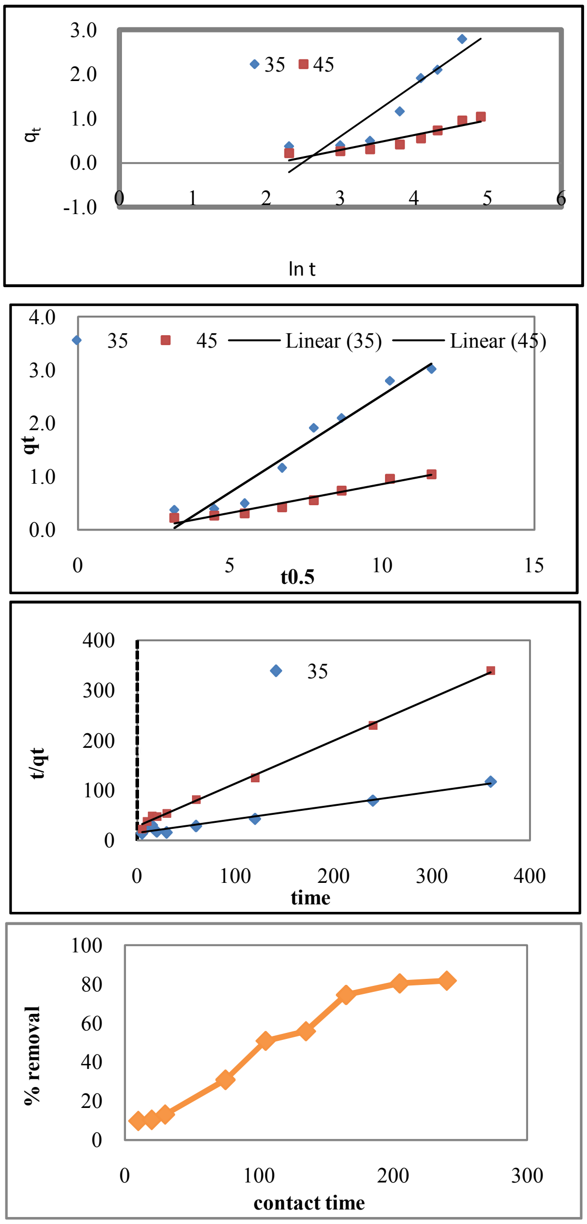

Figure 3 Different models used for kinetic study at 35°C and 45° C. (a) Elovich model (b) pseudo second order (c) intra-particle diffusion model (d) contact time vs % removal

Elovich kinetic first order equation produced initial rate of adsorption α and desorption rate β presented in table 2. Desorption constant upon increased temperature increased or initial rate constant decreased with temperature which means high desorption rate was favorable to high temperature.

Table 2 Constants calculated for different kinetic models.

	Pseudo second order		Weber-morris	Elovich	
Temperature	q_e	K_2	K	α	β
35°C	3.636	0.891	0.364	0.096	0.865
45°C	1.168	0.048	0.108	0.039	2.958

Isotherms Study

Temkin adsorption isotherm equation is given by

$$q_e = \frac{RT}{b_T}\ln A_T + \frac{RT}{b} \ln C_e, \qquad (4)$$

where, $B = \frac{RT}{b_T}$

b_t temkin isotherm constant, A_T binding constant (l/g), B heat of adsorption.

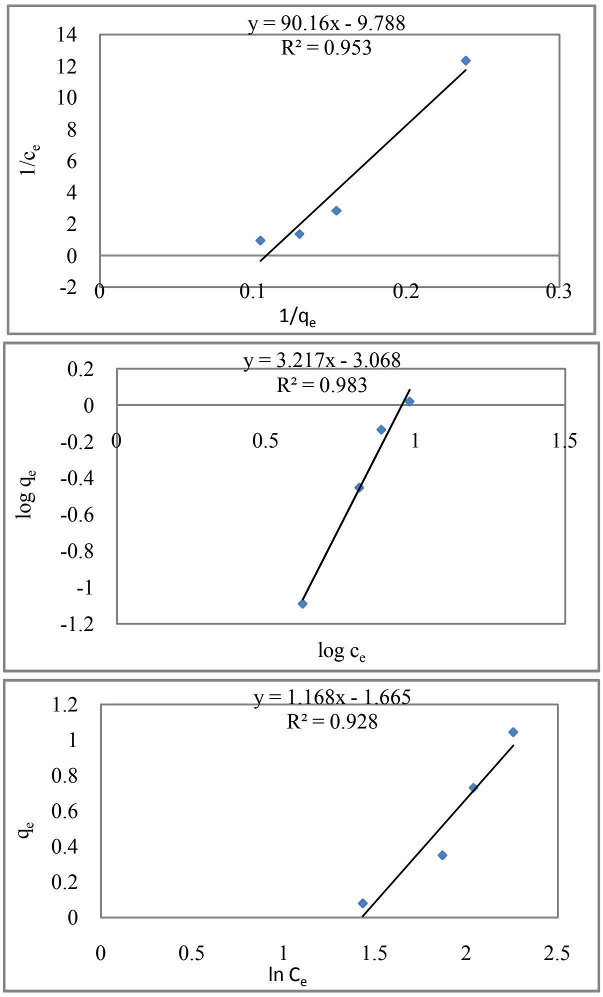

Figure 4 Adsorption isotherms plot for (a) Langmuir (b) Freundlich (c) Temkin at 35°C

From figure 4, it was observed that Langmuir and freundlich adsorption isotherm equation didn't well fit because both the adsorption isotherm gave negative intercept value which further was not able to calculate parameters concerned to Langmuir and freundlich isotherms. However, temkin adsorption isotherm well explained by experimental data. Experimental data obtained from analysis was able to calculate three important factors binding constant and heat of sorption. Heat of sorption as calculated from slope and intercept was 1.168 and binding constant was 0.240 l/g which clarifies the strong adsorbate-adsorbent interactions.

Table 3 Temkin adsorption isotherm constants for 35°C

	Temkin adsorption isotherm		
Temperature	**B**	b_t	A_T
35°C	1.168	1944.3	0.240

Influence of pH

One of important factor in case of adsorption known as pH. pH decides the nature of adsorbent and gives information about the strength. As it clearly indicated from the figure 5, at lower pH value % removal was high but later on at high pH value % removal was less active. This kind of behavior was due to nature of adsorbent and zero net positive charge effect. Similar kind of analysis as cited in literature [20].

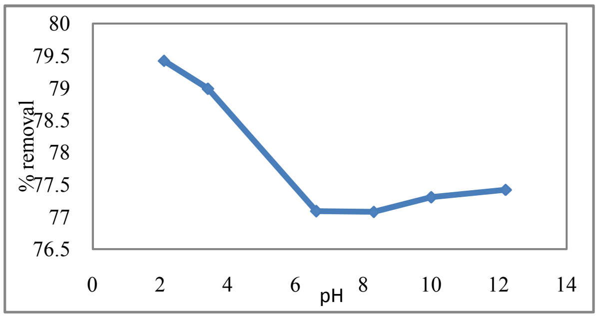

Figure 5 Effect of pH

CONCLUSION

SAC proves as efficient adsorbent with high surface area and pore diameter obtained by BET analysis. SEM characterization gives idea of surface which has number of active sites present. Evaluation of parameters is done by pH. Temkin adsorption isotherm best fit by experimental results obtained at room temperature from uv-vis spectrophotometer. Kinetic models found followed by chemical adsorption and best fit Second order and Elovich equation at 35°C and 45°C temperatures.

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