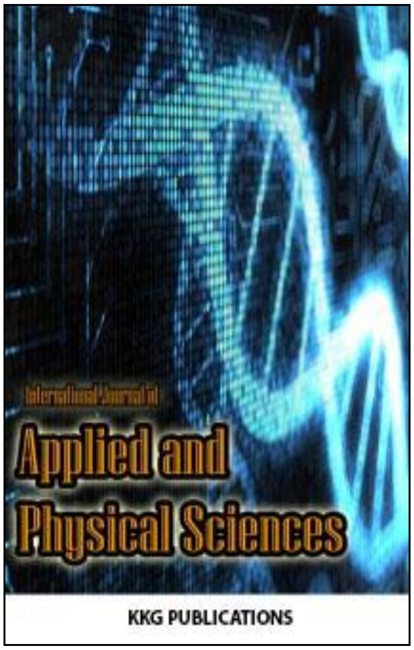

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FAREEDA HAYEEYE [1*], JIMMY YU [2], MEMOON SATTAR [3], WATCHANIDA CHINPA [4], ORAWAN SIRICHOTE [5]

[1, 3, 4, 5] Prince of Songkla University, Songkhla 90112, Thailand
[2] Griffith University Brisbane, Queensland 4111, Australia

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ADSORPTION OF LEAD (II) IONS FROM AQUEOUS SOLUTIONS BY GELATIN/ACTIVATED CARBON COMPOSITE BEAD FORM

FAREEDA HAYEEYE [1*], JIMMY YU [2], MEMOON SATTAR [3], WATCHANIDA CHINPA [4], ORAWAN SIRICHOTE [5]

[1, 3, 4, 5] Prince of Songkla University, Songkhla 90112, Thailand
[2] Griffith University Brisbane, Queensland 4111, Australia

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Abstract. A novel adsorbent, gelatin/activated carbon composite bead form (GE/AC), was used for adsorption and water treatment of lead(II) ions from an aqueous solution. Gelatin and activated carbon materials (GE/AC) were combined to form biosorbent to enhance the adsorption of lead(II) ions from an aqueous solution. The effect of adsorbent dosage was examined and evaluated. The highest percent adsorption capacity of 100%, 95.04% , 91.02% and 89.06% for 50, 100 , 200 and 300 mg L-1, respectively at GE/AC 0.21 g , pH 5 and 23±2 □C. The potential applications of GE/AC adsorbent in water treatment processes of lead (II) ions from aqueous by batch adsorption method were accomplished.

INTRODUCTION

Activated carbon (AC) powder is one of adsorbent which widely used for adsorption process to remove the toxic pollutants from waste water due to a large surface area, high porous, high capacity and high rate of adsorption. In addition, AC was prepared from agricultural wastes such as bagasse, oil palm shell, coconut shell and pericarp of rubber fruit and wood straw dust(in this study) [1]. The high surface area per unit volume characteristic of activated carbon is obtained with a two-step process which are carbonization and chemical or physical activation processes [2]. And Gelatin (GE) which is a biodegradable polymer was derived from collagen obtained from various animal by-products. . In this research the gelatin powder, is derived from peptone primagen of animal tissue. It is ecofriendly because a biodegradable polymer and easy to make bead form. Moreover, the chemical structure of GE consists of the amino group and the carboxylic acid group [3]. Therefore, The objective of this research use the novel adsorbent which are GE/AC composite into bead form for lead (II) ions sorption. In this work, the researcher studies the results of the effect of GE/AC dosage and effect of initial lead (II) nitrate concentration from the percentage adsorption of lead (II) ions on GE/AC composite bead form by controlling contact time and pH conditions.

MATERIALS AND METHOD

Materials

The GE/AC beads obtained from Department of Chemistry, Prince of Songkla University, Hat Yai, Thailand was prepared following the procedure described by [4]. The adsorbate which is $Pb(NO_3)_2$ with molecular weight of 331.2 g mol-1 was procured from UNILAB, UK. NaOH and HCl which are pH adjusted were purchased from Rowe Scientific and RCI labscan, respectively.

Method

Batch Adsorption Studies

The adsorption of lead (II) ions onto GE/AC 10% wt. was studied by batch adsorption method [5]. The effects of GE/AC dosage (0.03 - 0.21 g) and the effect of initial lead (II) nitrate concentrations (50,100, 200 and 300 mg L-1) were studied. All of the experiments studied by using 50 mL of lead (II) nitrate solutions at pH 5 were conducted in triplicate [6]. The initial pH of the lead (II) nitrate solutions were adjusted by using 0.1 M HCl and NaOH solutions. Batch adsorption method; 0.03 – 0.21 g of GE/AC were added into 50 mL of 50 ,100, 200 and 300 mg L-1 of lead (II) nitrate solution and the mixtures were agitated by rotary shaker at 23±2 °C. Lead (II) nitrate concentrations before and after adsorptions were determined by atomic adsorption spectrophotometer (GBC SDS-270) [7]. The metal removal percentage (R %) and the adsorption capacity, qe (mg g−1), of the adsorbent were calculated from this equation [8], [9] as follows:

$$R\ (\%) = \frac{(C_o - C_e)}{C_o} \times 100$$

*Corresponding author: Fareeda Hayeeye
E-mail: fareeda_hayeeye@hotmail.com

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

where C_0 and C_e are the initial and the equilibrium concentration of lead (II) nitrate (mg L^{-1}), respectively. V is the volume of the solution (L) and W is the mass of the adsorbent (g).

The adsorption isotherms: the Langmuir isotherms and Freundlich isotherm [10] which were represented by the following equation.

$$\frac{C_e}{q_e} = \frac{1}{q_m b} + \frac{C_e}{q_m}$$

$$\log q_e = \log K_F + \frac{1}{n} \log C_e$$

q_m and b are Langmuir constants which related to the maximum adsorption capacity (mg g^{-1}) and the adsorption equilibrium constant (L mg^{-1}), respectively. K_F and n are Freundlich constants which indicated to the adsorption capacity (L g^{-1}) and the adsorption intensity, respectively.

RESULTS AND DISCUSSION

Effect of GE/AC dosage and initial lead (II) nitrate concentrations. The dosages of GE/AC 10% wt. from 0.03 g to 0.21 g were used to study the effect of GE/AC dosage for the removal of 50, 100, 200 and 300 mg L^{-1} of lead (II) nitrate. The percentage of lead (II) ions sorption at equilibrium increased with increasing weight of GE/AC from 80.54% to 95.04%, 78.10% to 91.02% and 76.96% to 89.06% when increase dosage from 0.03 g to 0.21 g at initial lead (II) nitrate concentration 100, 200 and 300 mg L^{-1}, respectively at pH 5, and 23±2 °C. And the highest percentage of lead (II) ions sorption is 100% at equilibrium initial lead (II) nitrate concentration 50 mg L^{-1}, GE/AC 0.21 g, and 23±2 °C. The result indicated that an increase in adsorbent dosage increases the surface area and availability of adsorption sites [11]. On the other hand, the results from the effect of initial dye concentration represented that the percent adsorbed decreases with increasing initial concentration of lead (II) nitrate due to the number of lead (II) ions increase but the number of active sites of GE/AC adsorbent is limited [12]. All experimental data are shown in Fig. 1.

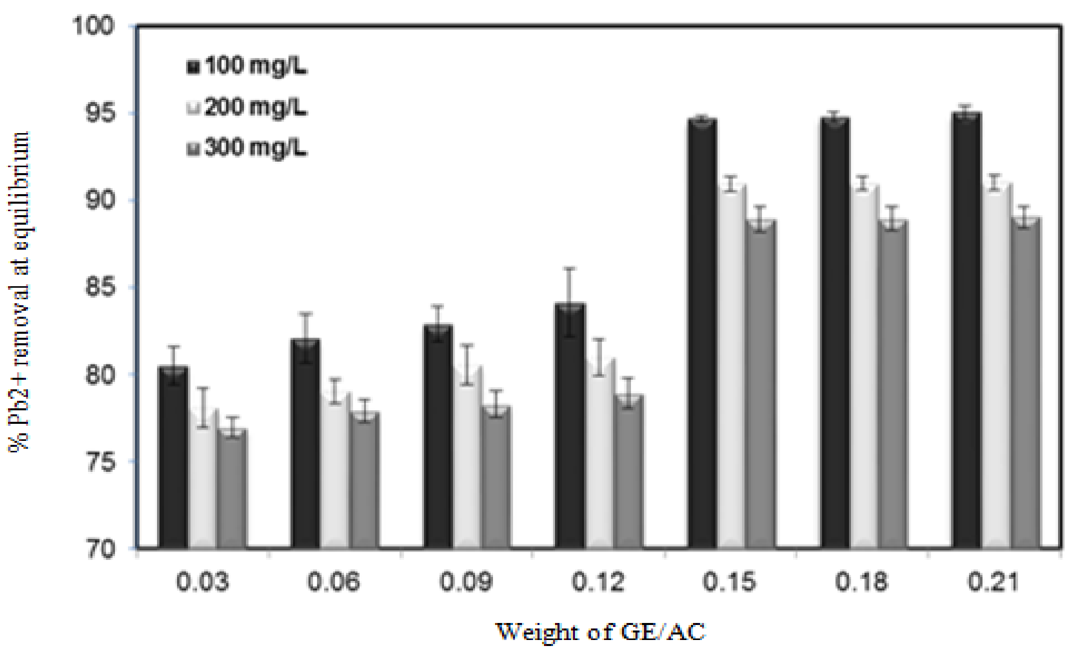

Fig. 1. Effect of Dosage (0.03 – 0.21 g) and effect of initial lead (II) nitrate concentration (50, 100, 200 and 300 mg L-1) for lead (II) ions sorption at 23±2°C, pH = 5.0.

In Fig. 2 shows the adsorption isotherm of lead (II) ions onto GE/AC and the experimental data were analyzed by the linear form of the Langmuir isotherms and Freundlich isotherms as shown in Fig. 3 (a-b). The parameter values of Langmuir isotherm and Freundlich isotherm which are describe the monolayer and multilayer of the GE/AC surface, respectively represent in Table 1. The result shows that the maximum adsorption capacity (q_m) from Langmuir isotherm is 370.37 mg g^{-1}. The lead (II) ions adsorption on GE/AC was well described by the Langmuir adsorption isotherm because the regression coefficient (R^2) is higher than the Freundlich isotherm.

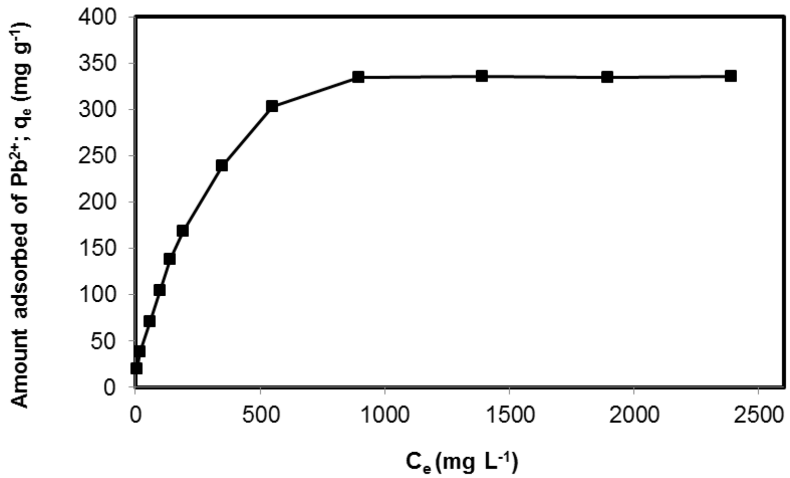

Fig. 2. Adsorption isotherm of lead (II) ions onto GE/AC at 23±2°C, pH 5.0.

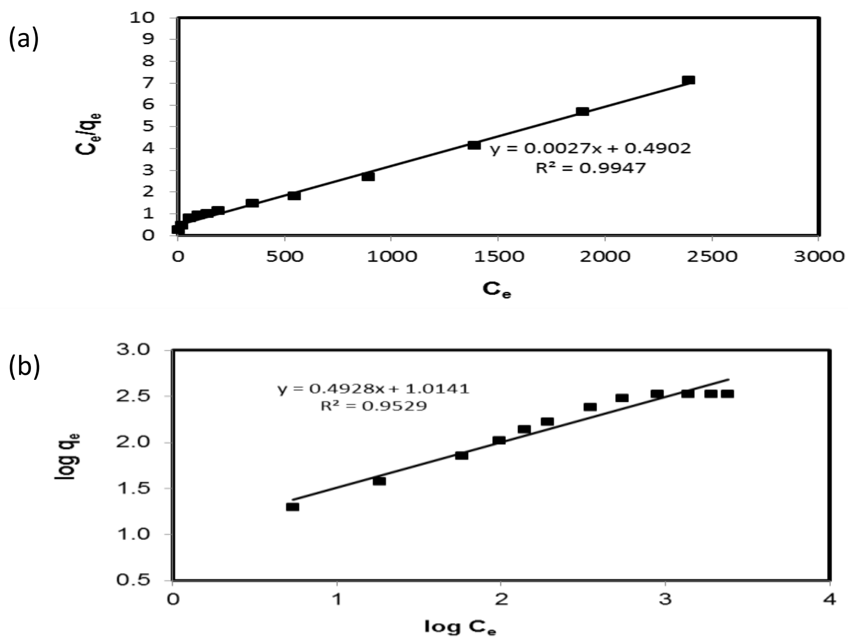

Fig. 3. (a) Langmuir and (b) Freundlich adsorption isotherm for lead (ii) ions sorption at pH 5.

TABLE 1
THE LANGMUIR AND FREUNDLICH CONSTANTS FOR THE ADSORPTION OF LEAD(II) IONS ONTO GE/AC

Langmuir constants			Freundlich constants		
q_m(mg g^{-1})	b	R^2	K_f	n	R^2
370.37	0.0055	0.9947	10.330	2.029	0.9529

CONCLUSION

The outlined results in this study refer to the strong capability of GE/AC to act as an efficient and eco-friendly biosorbent for removal, extraction and treatment of lead (II) ions from aqueous solution. The biosorption of lead (II) nitrate by GE/AC was found to be the percentage adsorbed decreases with increasing initial concentration of lead (II) nitrate from 100%, 95.04% , 91.02% and 89.06% for 50, 100 , 200 and 300 mg g^{-1}, respectively at GE/AC 0.21 g , pH 5 and 23±2 °C. The lead (II) ions adsorption on GE/AC was well described by the Langmuir adsorption isotherm. The percentage of adsorption of GE/AC increased with increasing weight of GE/AC and the highest efficiency of adsorption of lead (II) ions on GE/AC is 100%. Therefore, one of the bio-sorbent like GE/AC adsorbent was effective in removing lead (II) ions from waste water.

REFERENCES

[1] O. Sirichote, W. Innajitara, I. Chuenchom, S. Panumati, K. Chudecha, P. Vankhaew, and V. Choolert, "Adsorption of phenol from diluted aqueous solutions by activated carbons obtained from bagasse, oil plam shell and pericarp of rubber fruit," *Songklanakarin J. Sci.Technol.*, vol. 30, no. 21, pp. 85-189, 2008.

[2] L. Chuenchom, "Adsorption of cadmium (II) and lead (II) ions on activated carbons obtained from bagasse and pericarp of rubber fruit," MS, thesis, Prince of Songkla Univ., Thailand, 2004.

[3] N. Ninan, Y. Grohens, A. Elain, N. Kalarikkal, and S. Thomas, "Synthesis and characterization of gelatin/zeolite porous scaffold," *Euro. Poly. J.*, vol. 49, no. 9, pp. 2433-2445, 2014.

[4] F. Hayeeye, M. Sattar, W. Chinpa, and O. Sirichote, "Preparation and adsorption study of gelatin/activated carbon composite bead form," *Adv. Mater. Res.,*vol. 1077, pp. 18-22, 2015.

[5] M. E. Goher, A. M. Hassan, I. A. Abdel-Moniem, H. F. Ayman, M. H. Abdo, and S. M. El-sayed, "Removal of aluminum, iron and manganese ions from industrial wastes using granular activated carbon and Amberlite IR-120H," *Egy. J. of Aquat. Res.,* vol. 41, no. 1, pp. 155-164, 2015.

[6] T. Jose, and Y. Qiming, "Biosorption of lead(II) and copper(II) from aqueous solutions by pre-treated biomass of Australian marine algae," *Bioresour. Technol.*, vol. 69, no. 3, pp. 223-229, 1999.

[7] C. Faur-Brasquet, K. Kadirvelu, and P. Le Cloirec, "Removal of metal ions from aqueous solution by adsorption onto activated carbon cloths: adsorption competition with organic matter," *Carbon*., vol. 40, no. pp. 2387-2392, 2002.

[8] J. Goel, K. Kadirvelu, C. Rajagopal, and V. Kumar Garg, "Removal of lead(II) by adsorption using treated granular activated carbon: Batch and column studies," *J. Hazard. Mater.,* vol. 125, no. 1, pp. 211-220, 2005.

[9] Y. B. Onundi, A. A. Mamun, M. F. Al Khatib, and Y. M. Ahmed, "Adsorption of copper, nickel and lead ions from synthetic semiconductor industrial wastewater by palm shell activated carbon," *Int. J. Environ. Sci. Tech.,* vol. 7, no. 4, pp. 751-758, 2010.

[10] J. Rahchamani, M. H. Zavvar, and M. Behzad, "Adsorption of methyl violet from aqueous solution by polyacrylamide as an adsorbent: isotherm and kinetic studies," *Desalination,* vol. 267, no. 2, pp. 256-260, 2011.

[11] C. Namasivayam, and K. Kadirvelu, "Uptake of mercury (II) from wastewater by activated carbon from an unwanted agricultural solid by-product: coirpith," *Carbon*, vol. 37, no. 1, pp. 79-84, 1999.

[12] A. A. Jamal, M. O. Sulyman, K. Y. Elazaby, and M. A. Salah, "Adsorption of Pb (II) and Cu (II) from Aqueous Solution onto Activated Carbon Prepared from Dates Stones," *International Journal of Environmental Science and Development*, vol. 4, no. 2, pp. 191-195, 2013.