Results and Discussion

4.1 Effect of agitation time and initial Pb(II) concentration on modified jatropha seed husk.

The relationship between the amount of lead adsorbed on Jatropha seed husk modified by H_2SO_4 (70%) and contact time at various initial concentrations are show in Fig 4.1. From this figure, it can be seen that the amount of lead adsorbed (mg/g) increased with lengthening of agitation time and reached equilibrium after 30 min. Therefore, it was the equilibrium time required for the metal ion is very short. The majority of Pb(II) was removed within the first 30 min. Similar results have also been reported for the removal of Pb(II) ions (Raddad et al, 2002; Low et al, 1999). However, the experimental data were measured at 240 min to make sure that full equilibrium is reached. Moreover, it can be seen from the seam figure 4.1 that the adsorption of lead on the activated jatropha seed husk increases as initial lead concentration increases furthermore, the results of this study reveals that the amount of lead adsorbed at equilibrium (q_e) increased with increasing initial lead concentrations from 50 to 300 mg/L. This may be due to the fact that increasing the initial concentration of lead would provide an important driving force to overcome all mass transfer resistances of lead between adsorbate solution and adsorbent surface and therefore the rate which lead molecules pass from the bulk solution to the particle surface will increase. This would result in higher lead adsorption. The results also indicate that the lead adsorption was fast within the first 30 min, and thereafter it become slowly near the equilibrium. This phenomenon was due to the fact that a large number of vacant surface sites were available for adsorption during the initial stage, and after a lapse of time, the remaining vacant surface sites were difficult to be occupied due to repulsive force between adsorbate molecules on the solid and bulk phases. The high adsorption rate at the beginning of adsorption may also be due to the adsorption of lead by the exterior surface of the adsorbent. When saturation was reached at the exterior surface of the particles. This phenomenon takes relatively longer contact time. The fast adsorption at the initial stage is probably due to the increased concentration gradient between the adsorbate in solution and adsorbate in adsorbent as there must be increased number of vacant sites available in the beginning (Acharga et al, 2009).

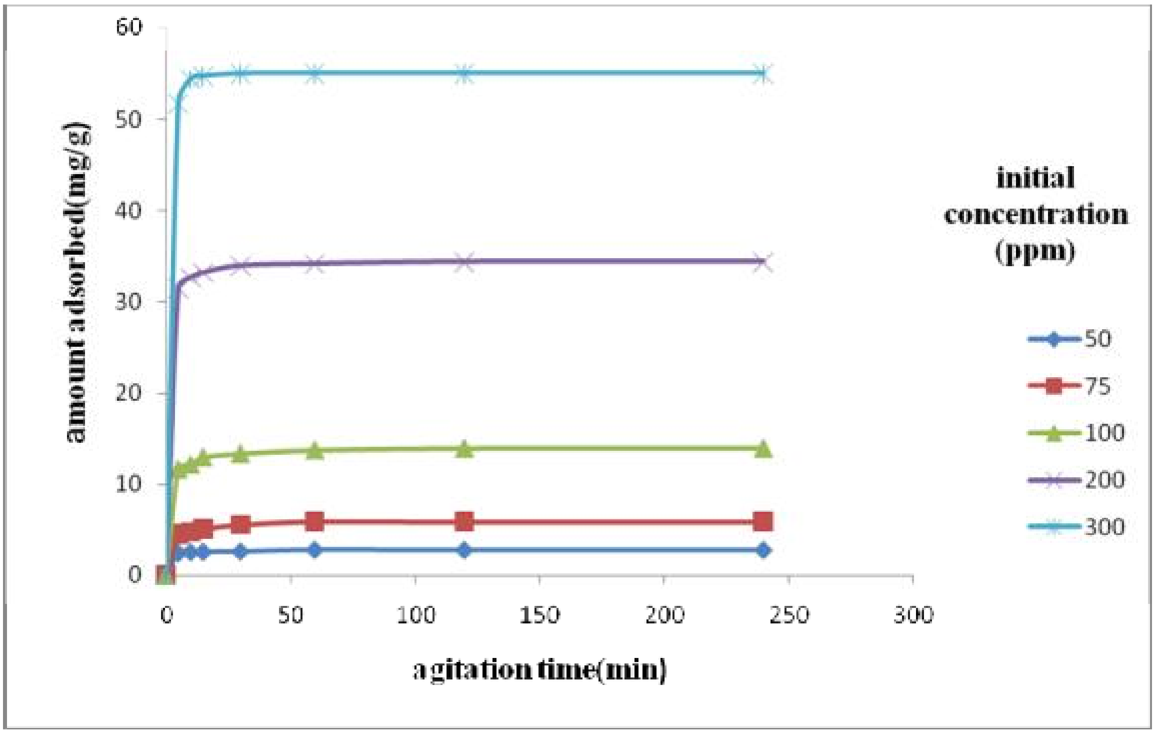

Figure 4.1: Adsorption kinetics of lead on jatropha seed husk with different initial lead concentration. Conditions: 250 µm particle size, 0.1 g/L dose, 298 K temperature and pH 5.5±2.

4.2 Adsorption isotherms

Adsorption isotherm is a curve which relates the amount of unadsorbed adsorbate remaining in solution to the amount of adsorbate adsorbed per unit mass of adsorbent at equilibrium time and the adsorption isotherms of Pb(II) concentration from 1.104 to 3 mgL^{-1} with a fixed adsorbent doses (0.1 g/25 mL) at pH 5.5±2 of Jatrophs seed husk were studied. The equilibrium adsorption isotherms are one of the most useful data to understand the mechanism of the adsorption.

4.2.1 Langmuir isotherm model:

The linear from of Langmuir equation was used to describe and analyses the equilibrium data of the lead adsorption on the Jatropha seed husk modified by H_2SO_4. From the slope and intercept of the liner plot of C_e/q_e versus C_e (Figure 4.2). The maximum adsorption capacities of this adsorbent and the Langmuir constant, $K_{L,}$ respectively were calculated as shown in Table 4.1. The calculated values of the maximum adsorption capacities of this sample of Jatropha seed husk, the Langmuir constant coefficients (R^2) are listed in table 4.2. It is evident from Table 4.2 that the Langmuir good agreement for represent the equilibrium data because the correction coefficient is 0.999. This indicate the homogeneous nature of the surface of Jatropha seed husk modified. The results also suggest the formation of monolayer coverage of lead molecule to the external surface of the activated Jatropha seed husk. Since the Langmuir equation assumes that the surface is homogenous(Zacar and engil 2005). All of the isotherm model parameters for the adsorption of lead(II) ions onto jatropha seed husk are listed in Table 4.1.

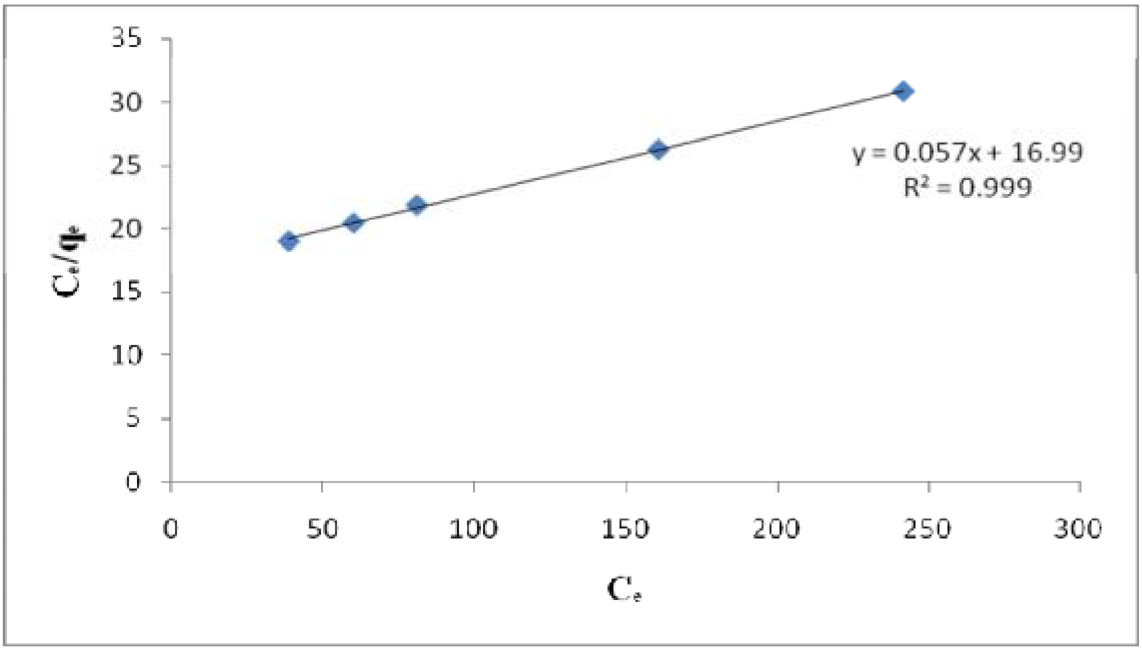

Fig 4.2 : Langmuir adsorption isotherm for pb(II) adsorption on Jatropha seed husk at pH 5.5±2; Dosage (0.1 g).

In addition, the essential characteristics of Langmuir isotherm was used to calculate a dimensionless constant called separation factor or equilibrium parameter (R_L) and the effect of isotherm shape has been discussed with a view to predict whether an adsorption system is favorable or unfavorable. Its mathematical formula was given as:

$$R_l = \frac{1}{1+bc_i} \qquad (4.1)$$

C_i is the initial metal concentration in mg/L and b is the energy of interaction at the surface. The significance of the R_l term is based upon an initial assumption of the applicability of the given data to Langmuir isotherm model, beyond which the value of R_L provides important information about the nature of the adsorption isotherm (see Table 4.1).

Table 4.1: Langmuir parameter R_L for the adsorption of lead on jatropha sees husk.

Initial concentration (mg / L)	R_L
50	0.8547
75	0.7968
100	0.7463
200	0.5952
300	0.4950

The values in table 4.1 of R_L at different concentrations of Pb(II) were calculated for Jatropha seed husk. The calculated R_L values at a different concentrations of Pb(II) fall within a favorable range. A graft was plotted R_L versus Ci (Fig .4.3) The R_L values were decreasing with increasing initial concentration of metal ion, as graft 4.3 showed that. This indicated that adsorption of Pb(II) ions at higher concentration were also still favorable for adsorption.

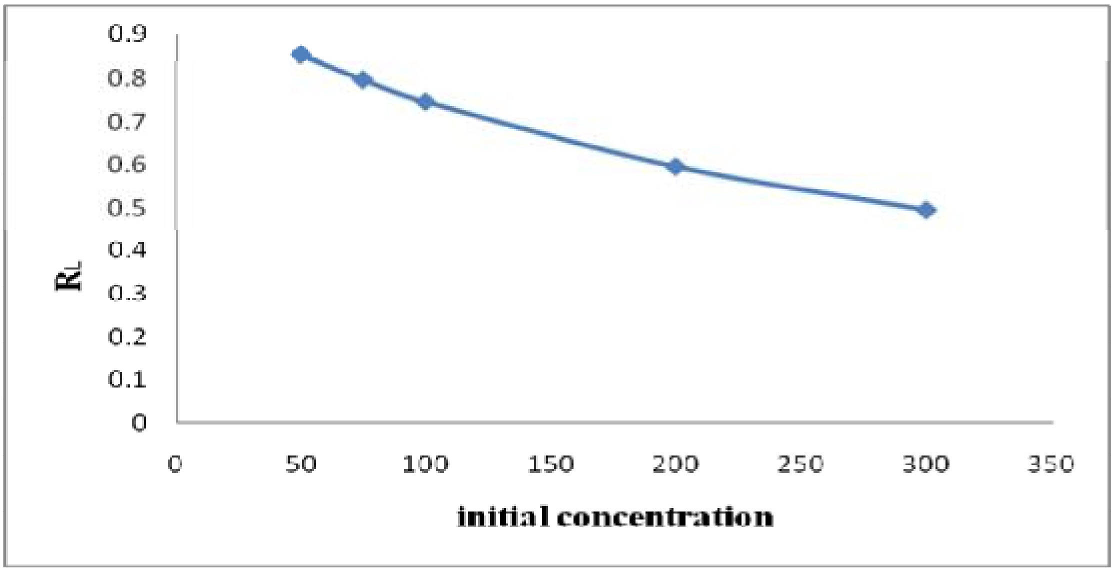

Figure 4.3. The calculated separation factor (R_L) against Pb(II) ions concentrations (mg/L)

Table 4.2: Adsorption isotherm constants for the adsorption of lead(II) ions onto Jatropha seed husk.

Adsorbent	T	Langmuir			Frindlish		
		b (L/ mg)	q_m (mg /g)	R^2	K_F	n	R^2
Jatropha seed husk	27	0.0034	17.5439	0.999	5.4325	-1.1820	0.997

4.2.2 Freundlich isotherm

As we have observed previously, the Langmuir isotherm model really fit with the equilibrium data of lead adsorption onto Jatropha seed husk modified by H_2SO_4 . Also the experiment data was analyzed by Freundlich isotherm model because Freundlich equation is an empirical equation employed to describe heterogeneous system, in which it is characterized by the heterogeneity factor 1/n. The Freundlich isotherm describes adsorption that does not restrict to the formation of the monolayer only. It also predicts that the lead adsorption on the surface of Jatropha seed husk modified will increase as long as there is an increased in the concentration of lead. The value of 1/n and K_f were obtained from the intercepts and slops of the plots of log q_e vs log C_e (Figure 4.4), respectively. The Freundlich parameters (K_f, 1/n, Freundlich exponent n and R^2) are listed in Table 4.2. As shown in Table 4.2. the value of Freundlich exponent n is lower than 1. Therefore, we can predict that the adsorption condition were unfavorite in the lead adsorption. The R^2 value of Freundlich isotherm model designated that the model is not fit then that of the Langmuir for the adsorption of lead on Jatropha seed husk modified. The Langmuir isotherm better fit to adsorption data than the Freundlich equation. The fact that the Langmuir isotherm fits the experimental data very well may be due to homogenous distribution of active sites on the jatropha seed husk surface. Langmuir model fits well compared with the R^2 values in Table 4.2.

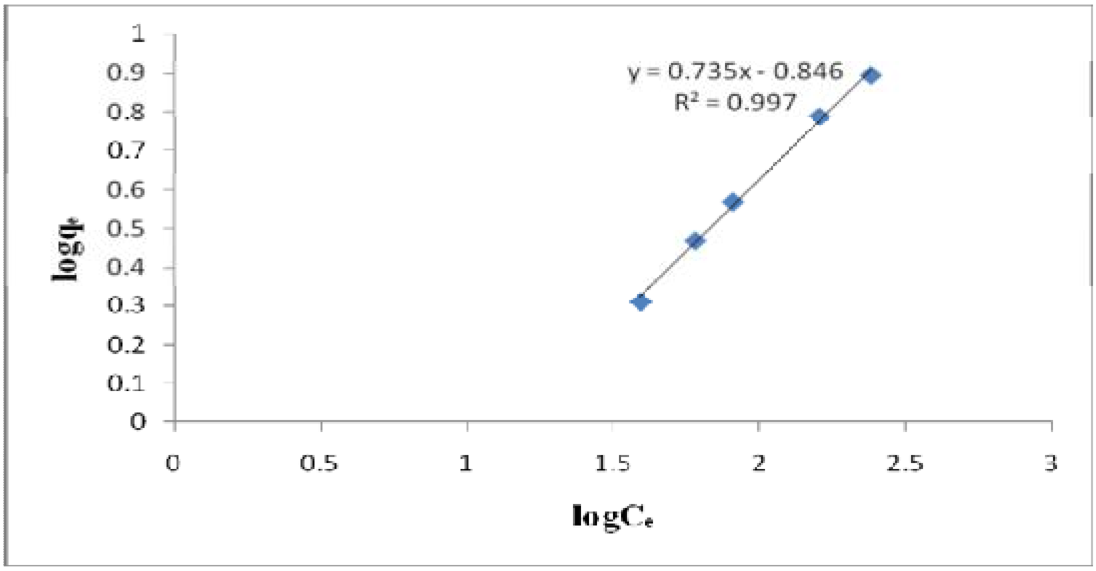

Fig 4.4 Linearized Freundlich isotherms for the adsorption of lead on Jatropha seed husk modified by Jatropha seed husk at room temperature.

4.3 Adsorption kinetics

The pseudo first-order and second-order equations models were used in this work to test the experimental data and examine the mechanism of lead adsorption of P Jatropha seed husk modified by H_2SO_4 at different initial concentration and room temperature 27 ± 1 °C. The plots of pseudo-first order and pseudo-second order for the adsorption of lead on the Jatropha seed husk are shown in Figures 4.5 and 4.6 respective. The kinetic parameters including ($K_{1,}$ q_e) ($q_{e,}$ k_2) of pseudo-first order and pseudo-second models were calculated from the slopes and intercepts of the plots of these kinetic models. The values of these parameters with their corresponding correlation coefficients (R^2) are given in Table 4.3. The correlation coefficients R^2 of pseudo-first order kinetic models were in the range from 0.519 to 0.998. The calculated values of the amount of lead adsorbed at equilibrium (q_e) from the pseudo-first order models were very much lower than the correlation coefficients

R^2 for the pseudo-second order kinetic model where its correlation coefficients were either 0.999 or 1. According to what has been mentioned above, we can suggest that the data of lead adsorption Jatropha seed husk fit pseudo-second order model.

Table 4.3. Pseudo-first and pseudo second order adsorption rate constants, the calculated and experimental q_e values for the adsorption of lead onto Jatropha seed husk modified by H_2SO_4 at different initial concentrations and room temperature.

Initial concentration of Pb(II) (mg/L)	Pseudo-first order kinetics			Pseudo-second order kinetics		
	q_e(mg/g)	K_L	R^2	q_e	K_L	R^2
50	8.7297	0.0461	0.519	100	0.009	1
75	41.6869	0.0484	0.998	166.67	0.003	0.999
100	228.5599	0.0507	0.986	-	-	0.999
200	40.6443	0.0484	0.981	500	0.004	1
300	7.9795	0.9673	0.902	1000	-	1

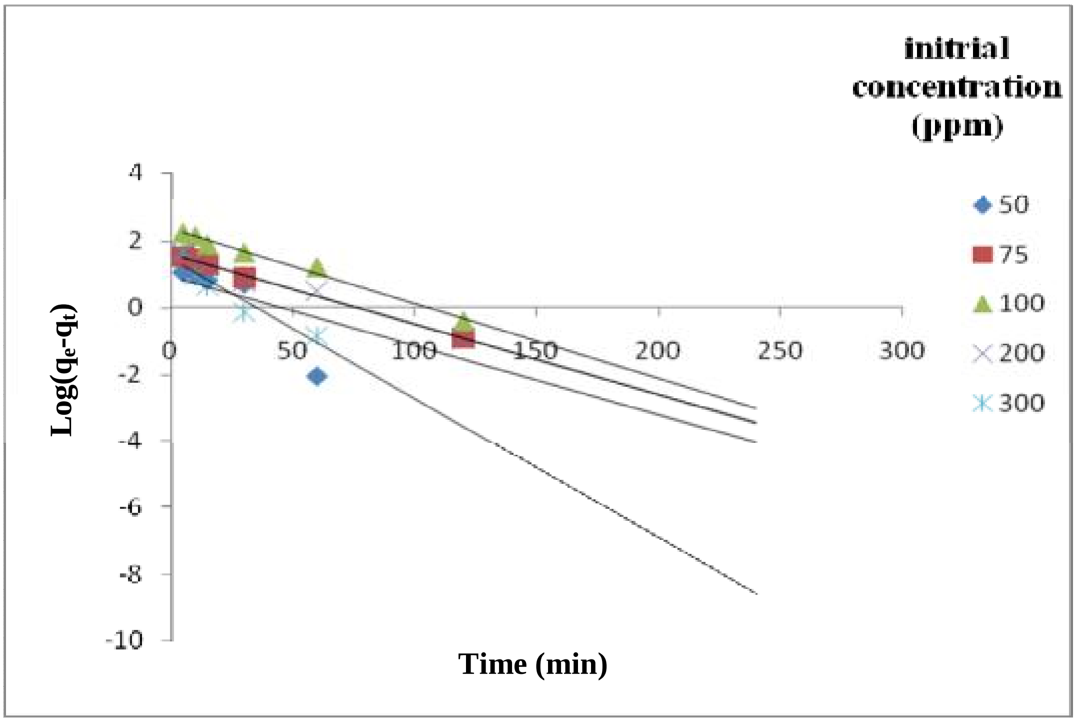

Figure 4.5. Pseudo-first order kinetics for the adsorption of lead on Jatropha seed husk modified by H_2SO_4 at different initial concentrations and room temperature.

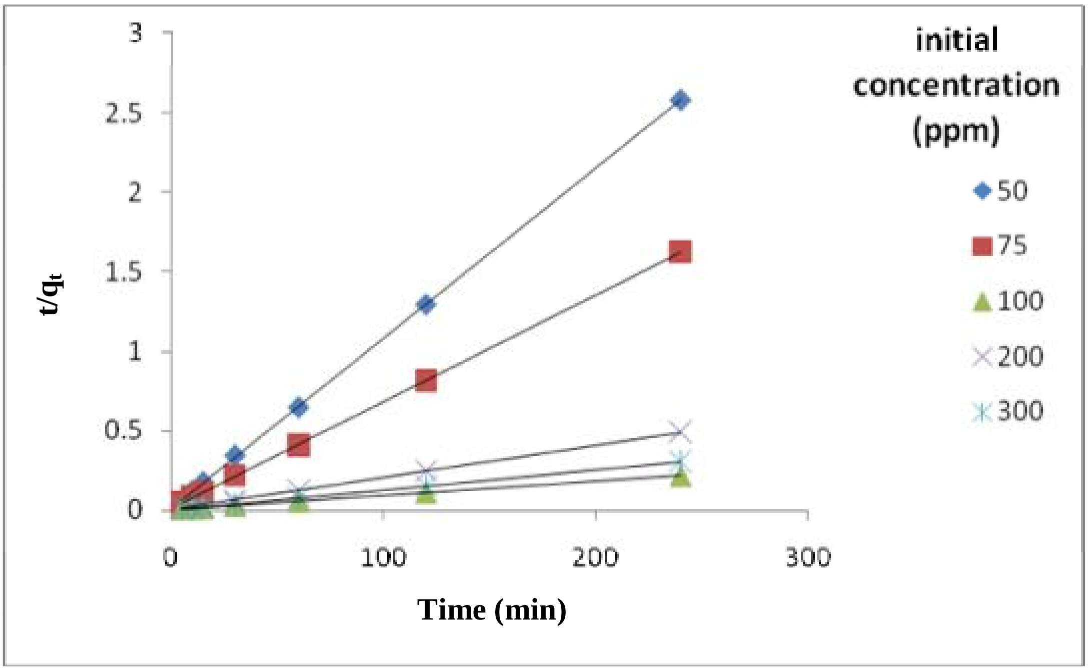

Fig .4.6. Pseudo-second order kinetics for the adsorption of lead on Jatropha seed husk modified by H_2SO_4 at different initial concentrations and room temperature.