Preparation of Chemical Modified Waste Corn Stalk by Urea for Removal of Lead (Ⅱ) and study on its adsorption Isotherm

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***Abstract*—Corn Stalk (CS) modified by urea and microwave was investigated as an adsorbent for Pb(Ⅱ) removal from aqueous solution. The preparing parameters on mass percent gain of Modified Corn Stalk (MCS) are analyzed using response surface methodology (RSM).The effects of PH and MCS dose on the Pb (Ⅱ) removal process were studied by using batch methods. The maximum adsorption capacity of Pb (II) onto MCS was found to be 12.78 mg/L. The adsorption isotherms were analyzed using the Langmuir and Freundlich isotherms. The results showed that the adsorption process was well described by Langmuir isotherm model with correlation coefficients (R) of 0.99998 for Pb (II) adsorption. Kinetic studies revealed that the adsorption process followed pseudo second order model.**

Keywords- Corn Stalk, modified, Adsorption, Lead

I. INTRODUCTION

Lead poisoning causes damage to reproductive system [1-2], the nervous system, kidney and brain. The major sources including mining, metal plating, batteries, paints, petroleum refining, steel and glass industries etc can cause lead pollution into wastewater [3]. Many technological methods have been used for toxic heavy metal ions removal such as chemical precipitation, ion exchange resin, membrane filtration, activated carbon adsorption and so on [4]. Cellulose contains a lot of hydroxyls groups; which can be modified by various chemical methods. The purpose of this study is to modify the Corn Stalk (CS) by urea and microwave as adsorbent for removal of Pd (Ⅱ) from aqueous solution. The influences of urea and microwave on Modified Corn Stalk (MCS) preparation and the effect of PH, MCS dose, contact time, initial metal concentration and temperature on the Pb(Ⅱ) removal process were studied by using batch methods. The adsorption properties of MCS were studied. Isotherm models (Freundlich and Langmuir) and kinetic models (pseudo first order and pseudo second order) were employed to describe the experimental data.

II. MATERIALS AND METHODS

A. Materials and Reagents

Raw Corn Stalk, urea, $CdCl_2$, NaOH, HCl.

B. Preparation of MCS

The CS was washed clean, dried and grinded to powder before preparation, Take CS and urea into a beaker and mix with some distilled water. Then put the beaker in a microwave oven with power at 500-900w for radiation and reaction. After reaction, cooled down to room temperature and washing with water. Then take the product into a blast oven for drying at 60℃ for 12h, The product was MCS.

C. Adsorption of Pb(Ⅱ)ion

Batch adsorption experiments were carried out in 200 mL flasks containing 100 mL of Pb^{2+} solutions. Throughout the experiments, pH varied between 1.0 to 7.0, contact time from 20 to 120 min, adsorbent dose from 0.5 to 2.5 g, temperature from 25 to 45℃, and initial metal concentration from 40 to 120 mg/L. The adsorption isotherm experiments were performed at 160rpm on a shaker with 0.1 g of adsorbent in flasks containing $CdCl_2$ solution at various concentrations and at the adsorption kinetic experiments were performed at an initial concentration of 100mg/L Pb^{2+} solution at 298 K. The Pb^{2+} concentrations in the filtrate was determined by flame atomic absorption spectroscopy.

D. Equilibrium Adsorption Isotherms

1)Freundlich Isotherm Model

The linearized form of Freundlich isotherm model.[5] is given as:

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

where K_F and n are Freundlich constants representing the adsorption capacity and intensity of adsorption. The adsorption capacity (K_F) and the adsorption intensity (1/n) are directly obtained from the slope and the intercept of the linear plot of log q_e versus log C_e.

2)Langmuir Isotherm Model

The linearized form of Langmuir Isotherm Model.[6] is given as:

$$\frac{C_e}{q_e} = \frac{1}{q_{\max} b} + \frac{C_e}{q_{\max}} \qquad (2)$$

where q_{max} is the maximum adsorption capacity and b is the equilibrium Langmuir constant related to adsorption energy. A dimensionless constant called separation factor (R_L) describing the essential characteristics of the Langmuir isotherm is calculated using the formula:

$$R_L = \frac{1}{1 + bC_0} \qquad (3)$$

where C_0 is the initial concentration of Pb^{2+}. The R_L value indicates the isotherm to be either unfavorable (R_L>1), linear (R_L=1), favorable (0<R_L<1), or irreversible (R_L=0).

III. RESULTS AND DISCUSSION

A. Effect of pH

pH has been identified as the most important factor affecting metal adsorption onto the adsorbent. This may be because of the fact that hydrogen ions themselves are strongly competing with the adsorbate. H^+ competes with metal cations for the available adsorption site whereas activate at higher pH value. When Pb^{2+} aqueous solution concentration was at 100 mg·L^{-1} and volume was 100mL, contact time was 100min, The effect of pH on adsorption capacities was investigated in the range 1-7. The results suggested that when pH of aqueous solution was at 4.0, The removal capacity was maximum.

B. Effect of MCS dose.

The removal efficiency and adsorption capacity of MCS adsorbent for Pb^{2+} was studied by changing the dose of adsorbent from 2 to 16g/L while the concentration of Pb^{2+} was 100mg/L and the volume was 100mL without change. The results show that, the RE of MCS increase with increasing of the amount of adsorbent at first. And when the dose of adsorbent was 10g/L, the RE was maximum, it was 90.21% and the experimental equilibrium adsorption capacity was 11.37mg/g.

C. Adsorption Isotherms

Freundlich isotherm for Pb(II) adsorption is shown in Fig.4 and the related parameters of the isotherm are given in Table 1. Langmuir isotherm for Pb(II) adsorption is shown in Fig.1 and Fig.2 and the related parameters of the isotherm are given in Table 1and Table 2.

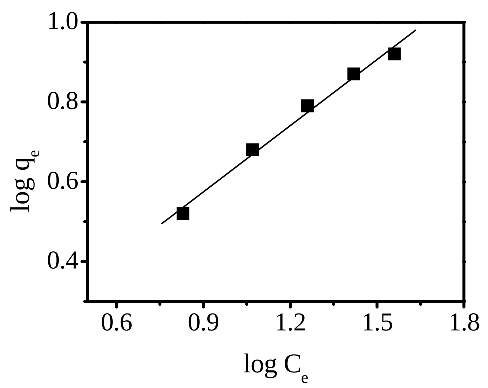

Figure. 1 Fitting of adsorption data with Freundlich isotherm (plot of log qe versus log Ce)

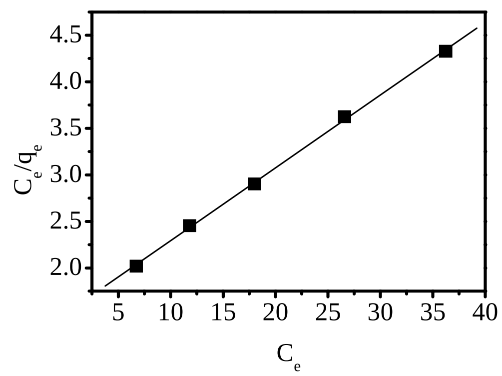

Figure. 2 Fitting of adsorption data with Langmuir isotherm(plot of Ce/qe versus Ce)

TABLE 1. PARAMETERS OF ADSORPTION ISOTHERM MODELS OF FREUNDLICH ISOTHERM

Freundlich isotherm		
n	K_F	R
1.19	1.81	0.9947

TABLE 2. PARAMETERS OF ADSORPTION ISOTHERM MODELS OF LANGMUIR ISOTHERM

Langmuir isotherm			
q_{max}(m/g)	R_L	b	R
12.78	0.33	0.052	0.9997

By comparing the correlation coefficients(R), it can be concluded that Langmuir isotherm provides a good model for the sorption system, which describes a monolayer adsorption onto the surface of the adsorbent with finite number of identical sorption sites[7]. The maximum adsorption capacity of Pb found was 12.78mg/g, the value of the dimensionless parameter RL(0.33) indicates that the adsorption is favorable (0<RL< 1).

D. Comparison studies

The adsorption capacity of MCS and CS adsorbent for removal of Cd(Ⅱ) ion from aqueous solutions was investigated in this study with a fixed condition(1.0g adsorbent for 100 mL of 100mg/L Cd(Ⅱ)ion solution at room temperature with PH of 4.0 and contact time of 100min).The results suggested that the maximum adsorption capacity of raw corn stalk increased from 6.53to 11.37mg/g after modification.

IV. CONCLUSIONS

From the present work, it can be concluded that the MCS adsorbent has a good adsorption capacity for Pb^{2+} from aqueous solutions. The removal efficiency of Pb^{2+}

was more than 90% and the max equilibrium adsorption capacity was 12.78 mg/g, compared with the similar adsorbent[9], the adsorption capacity was improved obviously. The obtained results showed that the Langmuir isotherm model is the best fitting model with the experimental data with high R value. Kinetic study showed that the adsorption process of metal ions can be explained with pseudo-second order model.

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