INVESTIGATION OF THE PROCESS OF MERCURY ADSORPTION FROM AQUEOUS SOLUTION BY ACTIVATED CARBON OBTAINED FROM FURFURAL

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Introduction

In recent years water pollution with organic compounds, metal ions, etc. is becoming a more serious problem. They have a harmful effect on human physiology and other biological systems. Mercury is generally considered to be one of the most toxic metals found in the environmental. Once mercury enters the food chains, larger accumulation of mercury compound takes place in human and animals. Mercury causes damage on the central nervous system and chromosomes [1]. The tolerance limit for Hg (II) for discharge into inland surface waters is 10 $\mu g\ dm^{-3}$ (ISI,1981) and for drinking water, 1 $\mu g\ dm^{-3}$ (ISI, 1991).
Activated carbons are widely used for removing of different pollutants from drinking water.

Recent interest in biomass sources for the production of energy, chemicals and activated carbons has renewed interest in furan compounds [2]. The aim of this study is to determine the adsorption capability of adsorbent obtained from furfural towards aqueous solution of mercury.

Experimental

Adsorbent was prepared by method described in [3]. The adsorption capacity of furfural adsorbent was determined by adding a definite amount of the sample to 50 ml of the aqueous solution of the $HgCL_2$ with different concentrations from 10-40 mg l^{-1} . The initial and equilibrium concentration of the Hg (II) in the solution was estimated spectrometrically (Specord UVVIS) using rhodamine 6G [4]

Langmuir isotherm study was investigated with different initials concentrations of Hg (II) from 10 to 40 mg l^{-1} while maintaining the adsorbent dose is 10 mg/50 ml.. Effect of pH on Hg (II) was studied for concentrations 20 and 40 mg l^{-1}, time of treatment 1h and carbon dosage 10 mg. Desorption studies were carried out with 0.5 M HCL and 2% KJ.

Results and Discussion

Examination of carbon characteristics (Table 1) indicates an insignificant ash content and low sulfur content. The composition and activation with water vapor lead to the formation of oxygen functional groups with different nature.

The great number of oxygen containing groups determines the hydrophilic character of carbon surface. It is of great importance for its application for removing off metallic pollutants from water.

Table 1 Some characteristics of the furfural adsorbent

Physico-chemical characteristics						Acid-base neutralization capacities/meq g^{-1} of the carbon surface				
surface area m^2/g	Ash content %	Pore structure m^3/g				Base uptake meq g^{-1}				Acid uptake HCL
		Vtot	Vmicro	Vmeso	Vmacro	$NaHCO_3$	Na_2CO_3	NaOH	EtONa	0.60
1100	0.12	0.890	0.425	0.110	0.285	0.25	0.16	0.23	1.50	

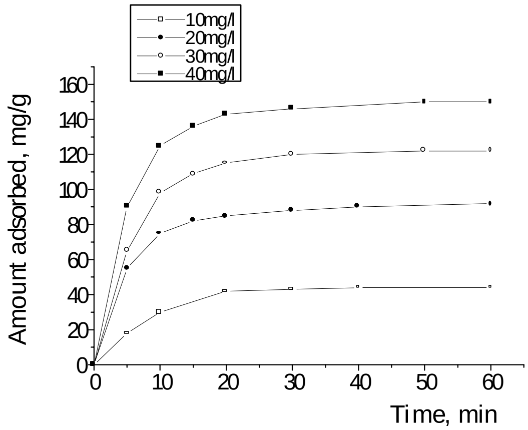

Figure 1. Effect of time of treatment and initial concentration of Hg[II] on the adsorption of Hg[II]

Figure 1 shows the effect of time of treatment and initial concentration on mercury adsorption by furfural adsorbent. The removal of mercury was rapid in initial stages of contact and gradually decreased with time of treatment.

The equilibrium time was 10, 30, 40 and 50 min for the concentrations used. The removal curves were Single, smooth and continuos indicating monolayer coverage of mercury on outer surface of adsorbent.

The kinetics of adsorption on furfural carbon follows first order rate equation, which can be presented by Lagergren expression [5]:

$$\log_{10}(q_e - q) = \log_{10} q_e \frac{k_{ad} t}{2.303} \quad (1)$$

where q_e and q are the amount of Hg (II) adsorbed (mg /g) at equilibrium and at time (min), and k_{ad} is the rate constant of adsorption.

We have obtained the linear plots of this equation for different concentrations, which indicate that the adsorption process follows the first order rate expression. The k_{ad} values, calculated at different initial metal ion concentrations are presented in Table 2.

Table 2 Adsorption rate constants k

Concentration of Hg (II) (mg l^{-1})	Lagergren rate constant k_{ad} (l min^{-1})
10	1.93×10^{-1}
20	1.53×10^{-1}
30	1.28×10^{-1}
40	0.97×10^{-1}

The Langmuir isotherm was applied for the adsorption equilibrium. It represented by the equation [6]:

$$\frac{C_e}{q_e} = \frac{1}{Q_o b} + \frac{C_e}{Q_o} \quad (2)$$

where C_e is the equilibrium concentration (mg l^{-1}), q_e is the amount of Hg(II) adsorbed at equilibrium (mg g^{-1}) and Q_o and b are Langmuir constants related to adsorption capacity and energy of adsorption, respectively.

Langmuir isotherm is valid for monolayer adsorption on a surface containing a finite number of identical sites. The model assumes uniform energies of adsorption on the surface and no transmigation of adsorbate in the plans of the surface.

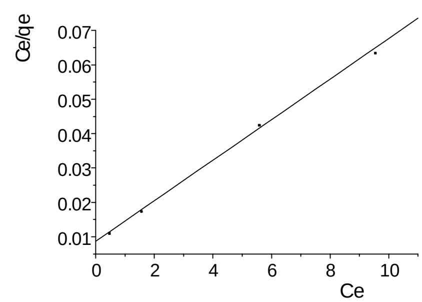

Figure 2. Langmuir plot for adsorption of Hg[II]

The linear plot of C_e/q_e versus C_e shows that the adsorption obeys Langmuir isotherm model (figure 2). Q_o and b were determined from the slope and intercept of the plot and are presented in Table 3.

Table 3. Langmuir constants

Q_o mg/g	b l/mg	Hg (II) concentration mg/l	R_l
174	1.40	10	0.067
		20	0.034
		30	0.023
		40	0.018

The dimensionless constant R_l was determined from Langmuir isotherm [6].

$$R_1 = \frac{1}{1 + bC_o} \quad (3)$$

where C_o is the initial metal concentration (mg l^{-1}) and b is the Langmuir constant (l mg^{-1})

The R_l values were found to be between 0 and 1, indicating favorable adsorption for mercury on furfural carbon for all concentrations studied Table 3.

The effect of the pH of the external solution on the extent of adsorption is investigated (Fig. 3). It can be seen that the adsorption decreases when the pH lowered from 5 .0 to 2.0. Attaining pH 5.0 the adsorption removal increases attaining constant values for higher pH values.

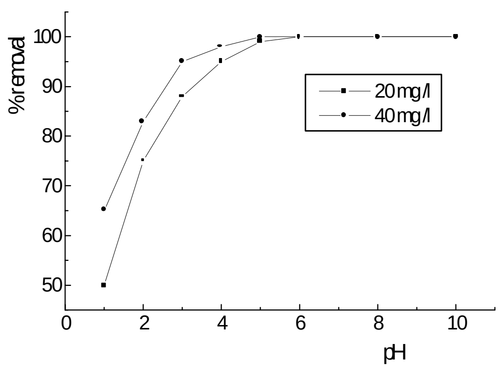

Figure 3. Effect of pH on Hg[II] removal.

The adsorbents with microporous structure are known with difficulty in the removal of adsorbed substances. We try to desorb the Hg (II) from metal loaded furfural adsorbent using HCL and KJ. The maximum percent recovery of Hg (II) was 94 % with HCL and 95% with KJ.

Conclusions

The results presented indicate that furfural activated carbon shows an ability to adsorb mercury from aqueous solution. The adsorption capacity was 174 mg g^{-1} at pH 5.0 Adsorption followed Langmuir isotherm. The adsorption of mercury decreases at low pH values and increases considerably over pH 4.0.

Acknowledgments

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