Effect of Ionic Strength on Adsorption of Corncob Xylitol Residue on Cr(VI)

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Abstract. The adsorption of xylitol residue in 200mg/L of Cr(VI) solution at different ionic strength was studied. Results show 97-99% of Cr(VI) can be effectively adsorbed when Ca and Na ion concentration was ten time of Cr, and the adsorbing ratio decreases with the increasing of Ca and Na concentration, indicating the competing adsorption of Na and Ca was not strong enough to reduce the adsorbing ability of xylitol residue greatly. Zn can reduce the adsorption ability of Cr when its concentration is only 1/10 of Cr concentration, and the adsorbing ratio decreases with the increasing of Zn ion indicating the competition effect of Zn with Cr. Cr concentration can not be determined accurately when Cu ion exist. Other determination method should be applied.

Introduction

It is reported that biomass such as corncob, bark, sawdust, peanut shell and rice hull can adsorb heavy metal ions in waste water and is a kind of cheap biomass adsorbent for waster water treatment[1-4]. Xylitol residue is hydrolysis waste of xylitol mill from corncob. The residue has high surface area, good hydrophilicity and porous structure and contains cellulose and lignin, which has similar chemical components as other biomass. Researches have been developed on the application of corncob hydrolysis residue, and results show that activated carbon prepared from xylitol residue and hydrolysis lignin has good adsorption property[5,6].

The author of this paper has studied the adsorption property of corncob xylitol residue on heavy metal ion in the previous paper [7], effects of pH, temperature, time and particle size were investigated and the results would offer an effective biomass adsorbent for waste water treatment on Cr(VI). This paper will continuously study the competition effect of other metal ions on adsorption of Cr(VI).

Experimentals:

1. Corncob xylitol residue was obtained from xylitol mill, the raw material was milled and screened to 80-100 mesh. Water content of xylitol powder was determined. The amount of xylitol residue in all experiments was based on the dry weight of the sample.

2． 0.1414g of $K_2Cr_2O_7$ was dissolved in 500mL of water to obtain a Cr solution of 100mg/L.

3. Determination of light absorption value of Cr: 0.25g of diphenylcarbazide was dissolved in 100mL of ketone and solution should be colourless. 30mL of 98% H_2SO_4 was dissolved in 210mL distilled water. 0.5mL of Cr solution was diluted to 50mL, 2.5mLof diphenylcarbazide solution and

2.5ml of sulfuric acid solution were added, light absorption value of the final solution was determined at 540nm on ultraviolet-visible spectrophotometer after 10 min.

Results and Discussion:

Effect of NaCl on the Adsorption of Xylitol Residue on Cr

10mL of $K_2Cr_2O_7$ (1g/L) was mixed with 0, 5, 10, 15, 20, 25 mL of 0.1mol/L NaCl solution, respectively. Distilled water was added to make the solution volume of 50mL and the final Cr(VI) concentration was 200mg/L (3.85mmol/L). 0.23g of xylitol residue (80~100mesh) was added to the solution. Then the solution was adjusted to pH2, and heated at 80℃ for 2h with stirring. Finally the mixture was filtered and 0.5mL of filtrate was taken out and diluted to 50mL and 2.5mLof diphenylcarbazide solution and 2.5ml of sulfuric acid solution were added, light absorption value of the final solution was determined at 540nm on ultraviolet-visible spectrophotometer after 10 min.

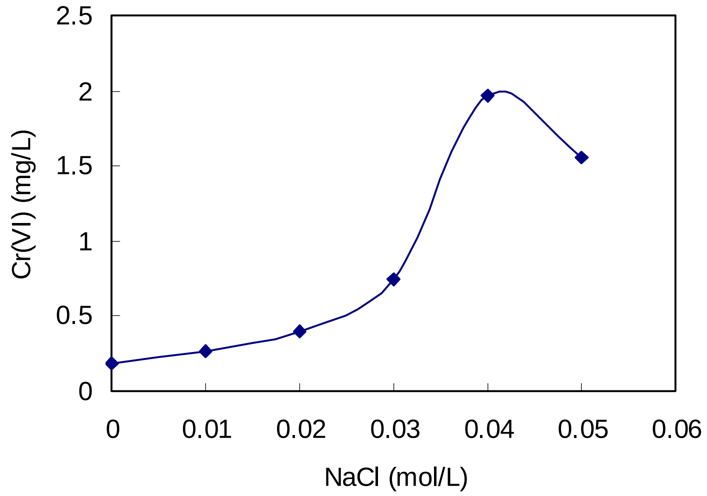

Fig.1 Effect of NaCl concentration on Adsorbing Property of Xylitol Residue

Fig.1 showed that Na^+ had negative effect on the adsorption of Cr (VI). When Na^+ concentration changed from 0.01mol/L to 0.03mol/L, Cr (VI) was still adsorbed by xylitol residue effectively. However, when Na^+ concentration was higher than 0.03mol/L, more and more Cr (VI) was left in solution. The results indicated although high Na^+ ion concentration affected the adsorbing ability of xylitol residue, the adsorbent can still adsorb 99% of Cr(VI) in the 200mg/L Cr(VI) solution (0.00385mol/L). Na^+ concentration had reached 0.04mol/L which was almost ten times of Cr concentration, showing the residue can effectively adsorb Cr at high Na concentration.

Effect of $CaCl_2$ on the Adsorption of Xylitol Residue on Cr

10mL of $K_2Cr_2O_7$ (1g/L) was mixed with 0, 5, 10, 15, 20, 25 mL of 0.1mol/L $CaCl_2$ solution, respectively. Distilled water was added to make the solution volume of 50mL and the final Cr(VI) concentration was 200mg/L(0.00385mol/L). 0.23g of xylitol residue (80~100mesh) was added to the solution. Then the solution was adjusted to pH2, and heated at 80℃ for 2h with stirring. Then the mixture was filtered and 0.5mL of filtrate was taken out and diluted to 50mL and 2.5mL of diphenylcarbazide solution and 2.5ml of sulfuric acid solution were added, light absorption value of the final solution was determined at 540nm on ultraviolet-visible spectrophotometer after 10 min. Results were shown in Fig. 2.

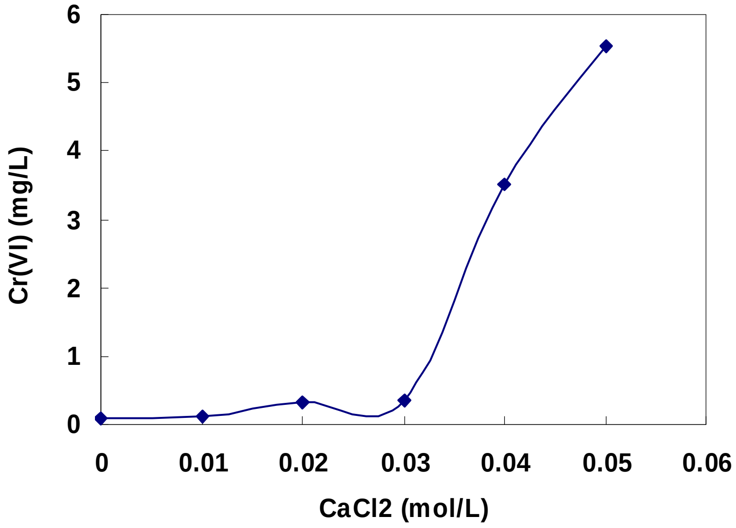

Fig.2 Effect of $CaCl_2$ Concentration on Adsorbing Property of Xylitol Residue

Fig.2 showed that $CaCl_2$ reduced the adsorption ability of xylitol residue on Cr (VI). When $CaCl_2$ concentration was low, the negative effect was not apparent, however, when the Ca concentration was changed from 0.03mol/L to 0.05mol/L, the residual Cr increased from 0.0358mg/L to 5.531mg/L. The results indicated that Ca ion competed with Cr (VI) at high ionic strength. Although Ca ion affected the adsorbing ability of xylitol residue, the adsorbent can still adsorb 97% of Cr (VI) in the standard Cr(VI) solution, showing the good adsorbing property of the residue. The concentration of Ca (0.04mol/L) was nearly ten times of Cr original solution (0.00385mol/L), indicating Cr ion can still be adsorbed at high Ca concentration.

Effect of $ZnCl_2$ on the Adsorption of Xylitol Residue on Cr

10mL of $K_2Cr_2O_7$ (1g/L) was mixed with 0, 5, 10, 15, 20, 25 mL of 0.1mol/L $ZnCl_2$ solution, respectively. Distilled water was added to make the solution volume of 50mL and the final Cr(VI) concentration was 200mg/L(3.85mmol/L). 0.23g of xylitol residue (80~100mesh) was added to the solution. Then the solution was adjusted to pH2, and heated at 80℃ for 2h with stirring. Then the mixture was filtered and 0.5mL of filtrate was taken out and diluted to 50mL and 2.5mL of diphenylcarbazide solution and 2.5ml of sulfuric acid solution were added, light absorption value of the final solution was determined at 540nm on ultraviolet-visible spectrophotometer after 10 min. Results were shown in Fig. 3

Fig.3 showed that the $ZnCl_2$ almost did not affect the adsorption of Cr(VI) when the $ZnCl_2$ concentration was lower than 0.4mmol/L, and almost all the Cr was adsorbed onto xylitol residue. But when the concentration of $ZnCl_2$ was higher than this value, $ZnCl_2$ started to compete with Cr and the adsorption ratio of Cr decreased to 97%. The adsorption ratio decreased with the increasing of Zn concentration. The results also showed that the Zn ion concentration was only 1/10 of Cr (VI) ion, and showed the negative effect on adsorption, indicating the heavy metal ion had stronger competition role when coexisted with Cr compared with Na and Ca.

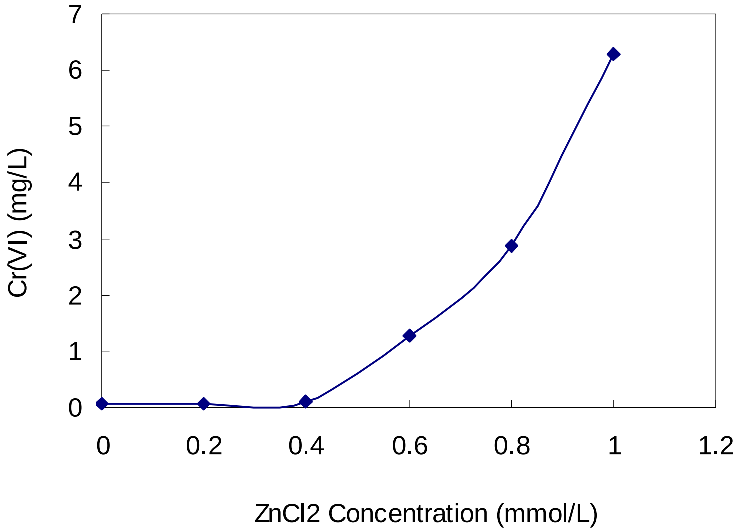

Fig.3 Effect of $ZnCl_2$ Concentration on Adsorbing Property of Xylitol Residue

The effect of Cu on the adsorption of Cr on xylitol residue was also studied. 1mmol/L of $CuSO_4$ was added into Cr solution (3.85mmol/L) and different amount of xylitol residue were added into the mixture, then the residual Cr concentration was determined, results were shown in the following table. Results showed determination of Cr could not be carried out accurately when Cu existed. Other determination method should be applied to investigate the interfering effect of Cu on Cr adsorption.

weight of xylitol residue（g）	0.20	0.22	0.24
Adsorbance (A)	0.283	0.286	0.279

Conclusions:

1. The adsorption of xylitol residue in 200mg/L of Cr(VI) solution at different ionic strength was studied. Results show 97-99% of Cr(VI) can be effectively adsorbed when Ca and Na ion concentration was ten time of Cr, and the adsorbing ratio decreases with the increasing of Ca and Na concentration, indicating the competing adsorption of Na and Ca was not strong enough to reduce the adsorbing ability of xylitol residue greatly.
2. Zn can reduce the adsorption ability of Cr when its concentration is only 1/10 of Cr concentration, and the adsorbing ratio decreases with the increasing of Zn ion indicating the competition effect of Zn with Cr.
3. Cr concentration can not be determined accurately when Cu ion exist. Other determination method should be applied.

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