PECULIARITY OF HEAVY METAL IONS ADSORPTION BY OXIDIZED KAU CARBONS FROM AQUEOUS MEDIA

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Introduction

The ability of oxidized carbons to ion exchange adsorption of one-, two- and three-charge cations of metals is quite good known [1]. It is interesting the adsorption of heavy metal ions as a therapeutic usage of oxidized carbons to remove them from organism under acute and chronic poisonings by metals (occupation and ecology depended diseases). Unfortunately, the application of these carbons as adsorption remedies requires an additional study the peculiarities of cation adsorption from multi-component salt solutions which imitate the biological media, so the presence of Ca^{2+} macro-component essential reduces the capture ability of adsorbent. That is why the quantitative evaluation of oxidized carbons KAU_{ox} ability to capture the ions of Ca^{2+}, Ni^{2+}, Co^{2+}, Cu^{2+}, Zn^{2+}, Sr^{2+}, Cd^{2+}, and Pb^{2+} from the solutions of corresponding soluble salts in the standard Ringer' solution was carried out. These data permit us to obtain the selectivity the selectivity raw for heavy metal ion adsorption in various concentration ranges and to estimate an affinity of carboxylic and phenolic groups to mentioned ions.

Experimental

As ion exchange adsorbents two types of oxidized carbons were chosen: $KAU_{ox}^{(1)}$ and $KAU_{ox}^{(2)}$ having not high level of oxidation; their static exchange capacity (SEC) on Na^+ ions equals 1.0 meq/g. Due to earlier developed methods of preparation of KAU-type oxidized carbons by oxygen of moisture air [2] it is obtained the samples: $KAU_{ox}^{(1)}$ with predominant contain of carboxylic groups (0.7 meq/g), mainly weak acid carboxylic groups (0.5 meq/g), and $KAU_{ox}^{(2)}$ with predominant contain of phenolic groups (0.7 meq/g). For both samples of oxidized carbons the isotherms of adsorption on heavy metal ions from solutions of the corresponding salts of various initial concentrations (from 10 till 0.5 mMol/l) in the medium of Ringer' solution having concentration on Ca^{2+} ions near 1 mMol/l was obtained. Linearized dependencies of distribution coefficients ($K_d = A/C_{eq}$; A - adsorption of ion, C_{eq} – equilibrium concentration of ion in the solution) from equilibrium concentrations gave us the significance's of K_d under standard conditions (C_{eq} = 1 mMol/l) and at "physiological" concentrations of corresponding ions (Ni^{2+}, Co^{2+}, Cu^{2+}, and $Zn^{2+} \sim 10^{-2}$ mMol/l, $Pb^{2+} \sim 10^{-3}$ mMol/l, $Cd^{2+} \sim 10^{-4}$ mMol/l, $Sr^{2+} \sim 10^{-5}$ mMol/l). "Physiological" level of Ca^{2+} was taken as 1 mMol/l. It was also obtained the affinity coefficients of functional groups to various cations ($K_a = K_d^{Carb}/K_d^{Phen}$) as well selectivity coefficients of cations relative to Ca^{2+} ($K_s^{Me/Ca} = K_d^{Me}/K_d^{Ca}$). Determination of concentrations of ions in solutions was carried out by complexometry with EDTA.

Results and Discussion

The dependencies of K_d from C_{eq} of various ions for oxidized carbons of $KAU_{ox}^{(1)}$ and $KAU_{ox}^{(2)}$ are shown on Figures 1 and 2. The significance of K_d, K_a, and K_s for standard conditions (C_{eq} = 1 mMol/l) and for the level of "physiological" concentrations of these ions are presented in Table 1.

It is found that under standard conditions the carboxylic groups in comparison with phenolic ones appear a higher affinity to ions of Cu^{2+}, Ni^{2+}, Co^{2+}, and Cd^{2+}, and lower affinity to ions of Pb^{2+} and Sr^{2+}. The affinity of functional groups of both types are practically equal to ions of Ca^{2+} and Zn^{2+}. For the "physiological" concentrations a higher affinity of carboxylic group remains only to ions of Cu^{2+} and Ni^{2+}; a higher affinity of phenolic groups remains to ions of Sr^{2+} and Pb^{2+}, and extremely rises to ions of Co^{2+}. The affinity of carboxylic and phenol groups becomes almost equal to ions of Cd^{2+} and Zn^{2+}.

It was also found that under standard conditions the oxidized carbons have an appeared selectivity on ions of Cu^{2+}, Co^{2+}, Ni^{2+}, Pb^{2+}, and Cd^{2+}; adsorbents are not selective to ions of Zn^{2+} and Sr^{2+}. The raw of selectivity on adsorbed ions on the samples of oxidized carbons KAU_{ox} type can be presented as follows:

$KAU_{ox}^{(1)}$: Cu>>Co>Ni>Pb>Cd>**Ca**~Zn>Sr
$KAU_{ox}^{(2)}$: Co>Cu>Pb>Ni>Cd>**Ca**~Zn>Sr

In the field of "physiological" concentrations the selectivity of oxidized carbons appears regards to ions of Pb^{2+}, Ni^{2+}, Co^{2+}, Cd^{2+}, and Zn^{2+}. Adsorbents practically are not selective to ions of Sr^{2+} and completely loose the selectivity to ions of Cu^{2+}. It was

obtained the following adsorption selectivity raw on studied ions for samples of oxidized carbons of KAU_{ox} type:

$KAU_{ox}^{(1)}$: Pb>Ni>Co>Cd>Zn>**Ca**>Cu>Sr
$KAU_{ox}^{(2)}$: Pb>Co>Ni>Cd>Zn>**Ca**~Sr>Cu

Conclusions

It is obtained the selectivity raw of heavy metal ions adsorption on oxidized carbons KAU_{ox} with various relationship of carboxylic and phenolic groups. It is shown that to desirable remove the ions from multi-component solutions by these carbonaceous ionites the concentration fields of ion exchange adsorption as well qualitative content of functional groups on these adsorbents should be taken into account.

References

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2. Kartel N, Stavitskaya S, Petrenko T, Gerasimenko N. Thermooxidation peculiarity of active carbon surface by oxygen of moisture air. Eurocarbon'98: Science and Technology of Carbon. Extended Abstracts and Programme. Strasbourg (France): AKK-GFEC, 1998, Volume 1; 297-298.

Table 1. Adsorption Selectivity for heavy metal ions on oxidized carbons of KAU_{ox} type.

Me^{2+}	Standard conditions (C_{eq} = 1 mMol/l)					"Physiological" level				
	K_d, ml/g		K_a, Carb/Phen	$K_s^{Me/Ca}$		K_d, ml/g		K_a, Carb/Phen	$K_s^{Me/Ca}$	
	-COOH groups	Ph-OH groups		-COOH groups	Ph-OH groups	-COOH groups	Ph-OH groups		-COOH groups	Ph-OH groups
Ca^{2+}	240	220	1.09	1	1	240	220	1.09	1	1
Ni^{2+}	520	420	1.24	2.17	1.91	1260	940	1.34	3.32	3.03
Co^{2+}	890	780	1.14	3.71	3.54	1170	1510	0.77	3.08	4.87
Cu^{2+}	2750	480	5.73	11.5	2.18	320	230	1.39	0.84	0.74
Zn^{2+}	240	220	1.09	1.0	1.0	550	580	0.95	1.45	1.87
Sr^{2+}	80	90	0.89	0.33	0.41	360	450	0.80	0.6	1.02
Cd^{2+}	320	280	1.14	1.33	1.27	1180	1160	1.02	2.23	2.90
Pb^{2+}	380	440	0.86	1.58	2.0	1630	1780	0.92	3.54	5.08

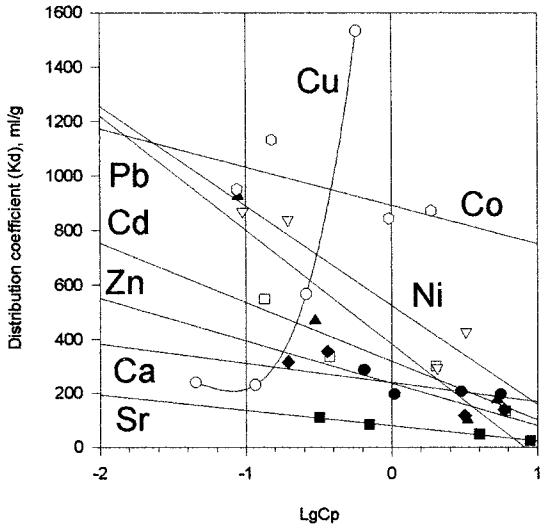

Figure 1. K_d vs C_{eq} for carboxylic groups

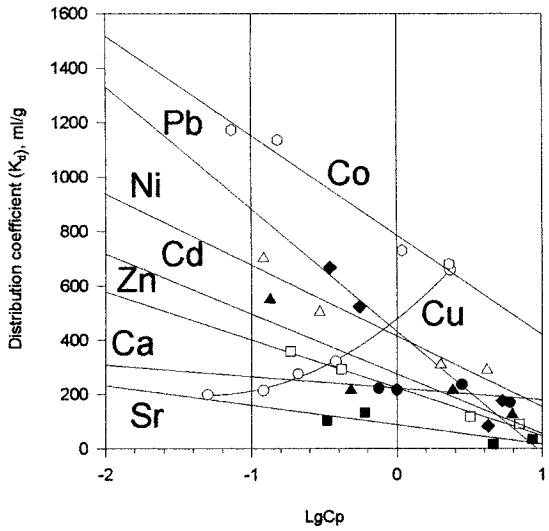

Figure 2. K_d vs C_{eq} for phenolic groups