SORBTION OF HEAVY METAL IONS BY ACTIVE CARBON-CLAY COMBINED ENTEROSORBENT "ULTRASORB" FROM MULTICOMPONENT SOLUTIONS

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Introduction

The medical application of oxidized carbons in H- and salt-forms as the adsorption remedies to regulate the acid-base balance of organism and its electrolyte status, and to remove some short-lived radionuclides from organism should be considered as quite successful [1]. The practical tasks require the development of new selective adsorption materials with poly-functional ion exchange centers, for example, the combined adsorbents on the base of oxidized carbons and natural clay minerals having the properties of inorganic ionites. Recently we have developed [2] a new binary enterosorbent "Ultrasorb" on the base of a modified carbonaceous material – dispersed activated and oxidized fiber carbon in a salt-form and a clay mineral - Palygorskite modified by heteropolyacid clusters having high selectivity to ions of cesium.

The main aim of this study was the estimation of selective ability for binary adsorption remedy to ions of some toxic heavy metals and radiocesium.

Experimental

Adsorption experiments were carried out under static conditions: shuttling of adsorbent (m = 0.1 g) in solution of corresponding salt (20 ml) with various initial concentrations on the base of standard Ringer' solution. Initial and equilibrium concentrations of metals were detected by atomic absorption spectroscopy and also were controlled by complexometry method. It was considered only close data obtained both independent methods. The measures of radiocesium adsorption were made on the radioactive solution with initial activity of ^{137}Cs achieved 2.55-5.25 Bq/ml. Activities of adsorbent and equilibrium solutions were detected by radiometer RUP-4.

Results on adsorption of heavy metal ions by Ultrasorb have permitted to compose the isotherms of adsorption and to calculate the distribution coefficients (K_d, ml/g). Firstly they have shown the quantitative selectivity scale for the toxic heavy metal ions captured by new medical adsorption drug.

Results and Discussion

Dependencies of K_d for the various ions in the systems "Ultrasorb-solution" from their equilibrium concentrations are presented on the Figure 1. It can be stated that for the intermediate concentrations (10^{-2} – 1 Mol/l) the selectivity raw of metal ions is following:

Pb>Co>Cu>Ni>Cd>Zn>Sr

It should be also stressed that the values of K_d for these ions are very small changeable for binary enterosobents with various "carbon-clay" ratio (from 4:1 till 1:4). Practically the same is found for K_d-values of radiocesium. The diagram on the Figure 2 confirms the negligible differences for K_d-values of ^{137}Cs in the case of various ratio of carbon and clay in enterosorbent.

The diagrams of distribution of K_d-values for various ions in the systems "Ultrasorb-solution" under standard conditions (C_{eq} = 1 mMol/l) and for the "physiological" concentrations of corresponding ions are presented on Figure 3. Everyone can see that Ultrasorb has exclusively high selectivity and to ^{137}Cs, and to some toxic heavy metals, such as Pb, Co, Cd, Cu, etc.

Summarizing the therapeutic action of new adsorption remedy "Ultrasorb" it should be pointed that this drug has excellent combination of curative properties (see Table 1). Among them there are effective removal ability on toxic heavy metal ions as well as purification ability on ^{137}Cs–isotopes, some toxic compounds and harmful metabolites, correction of biochemical balance of organism. That is why a binary carbon-clay drug "Ultrasorb", which is on the second phase of clinical testing in Ukraine, has wide perspectives to be used for profilaxy and treat of lot of occupational and ecology depended diseases, especially for the regions with high radionuclide and heavy metal contamination.

Conclusions

It is obtained the selectivity raw of heavy metal ion adsorption on Ultrasorb. Quantitative data on distribution coefficient on metal ions and ^{137}Cs appear a high removal ability of this drug. This has to widen an application of Ultrasorb in medicine.

References

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2. Strelko VV, Kartel NT, Stavitskaya SS, Petrenko TP, Gerasimenko NV, Davydov VI. Adsorption drug "Ultrasorb" for removal of radionuclides from organism. Ukrainian Patent 20718A, 1997.

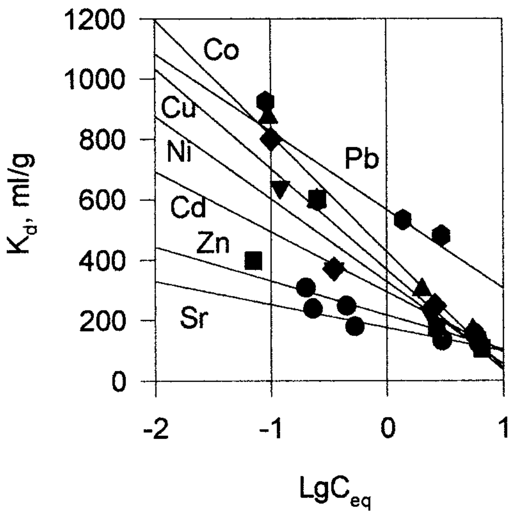

Figure 1. K_d vs C_{eq} for various ions

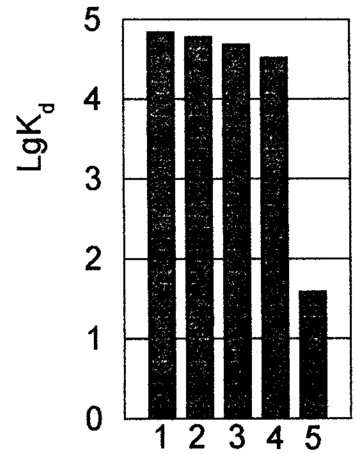

Figure 2. Coefficient of distribution on ^{137}Cs for: clay -1, carbon - 5, and clay/carbon mixture: (3:1) - 2, (1:1) - 3, and (1:3) - 4

Table 1. Therapeutic action of Ultrasorb on organism

Removal of radiocesium	K_d (^{137}Cs) > 20000 ml/g
Removal of heavy metal ions	**K_d (Pb, Co, Cd, Cu, etc) > 1000 ml/g**
Detoxification capture of organic metabolites and poisons	Adsorption on methylene blue > 350 mg/g
Correction of physiological processes	Positive dynamics of shifts in protein, lipid, ensyme and electrolyte balances

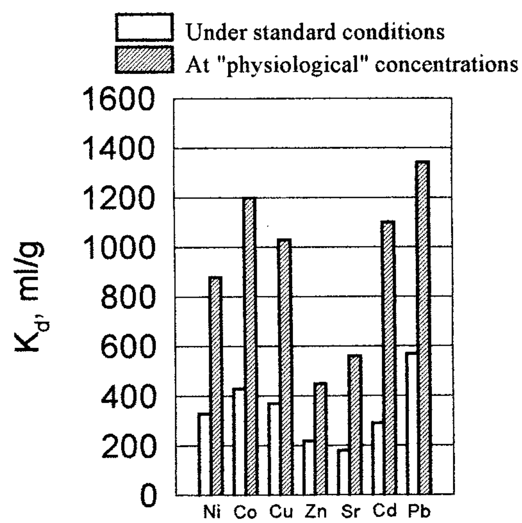

Figure 3. Digram of Kd for various heavy metal ions in systems "Ultrasorb-solution"