

SELECTIVE SORPTION OF PLATINUM METAL MIKROAMOUNTS BY CARBON MATERIALS

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Introduction

Most of carbon materials - natural and technical coals, especially their activated and modified forms - are known to be effective adsorbents for evaluation of different organic compounds as well as metal ones from water solutions. Some of them are commonly used for selective extraction of valuable and toxic metals from solutions with complex composition. It allows to use them for solving different industrial and ecological problems [1]. Thus far the information concerning using of carbon materials as adsorbent of mikroamounts of platinum metals is limited [2-3].

In this communication the results of investigations of sorption properties of various carbon materials for platinum metals mikroamounts evaluation from water solutions are summarized. The possible reason of these adsorbents strong selectivity is discussed.

Experimental

The set of carbon materials to be studied included the natural and technical coals and products of their proceeding (anthracite and their different activated and oxidized samples, sulfocoals, brown coals, cokes, long flame coals, charcoals and others); synthetic coals as containing various surface groups as practically without them; carbon fibres and their activated, oxidized and sulfated forms.

The water solutions containing mikroconcentration of compound of platinum metal (palladium, ruthenium, rhodium or iridium) are the main objects of investigation. The one-component solutions with the platinum metal compound and the same with 100-500-fold excess of commonly accompanying metals (copper, iron, cobalt, nickel, manganese, chromium, aluminum, zinc) were studied. The sorption ability and selectivity of carbon materials for evaluation of platinum metals' compounds were examined in dependence on coal composition, solution's acidity and other factors in static and dynamic conditions.

Results and Discussion.

All carbon materials under study were found to be adsorbents for mikroamounts of platinum metals' evaluation from water solutions with various acidities, but their sorption capacity differs in dependence on adsorbent used and on metal to be extracted.

All investigated carbon materials demonstrated the strong selectivity for evaluation of mikroamounts of platinum metal compounds from water solutions independently on adsorbent nature and composition: the sorption of metal under consideration from water solutions does not depend on the presence of excess of other accompanying components. This sorption selectivity was found for all studied platinum metal while values of their sorption capacity on the same coal differ essentially. Figure shows the sorption

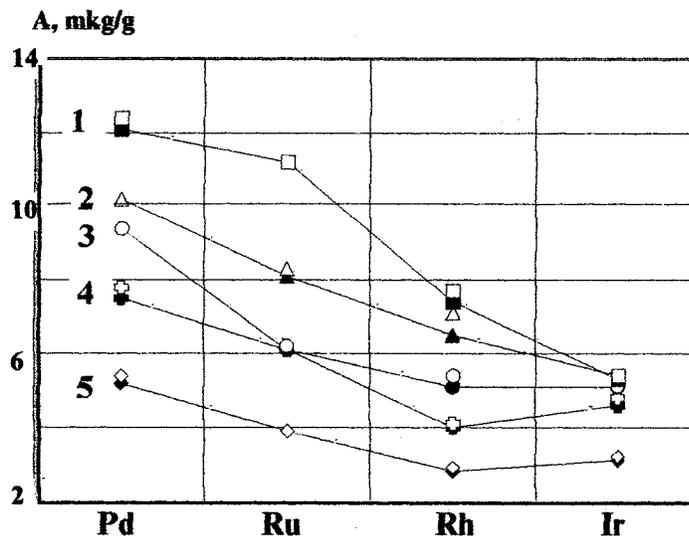


Figure 1. Sorption capacity of some carbon materials for evaluation of 1 mg/l platinum metal compounds from 1 M hydrochloric acid solutions.

capacity of some carbon materials (activated anthracite, AA (1); nitrogen containing synthetic coal, SKN (2) and their oxidized form, SKNO (3); carbon fibre, CF (4), and their oxidized form, CFO(5)) for evaluation of 1 mg/l of palladium, ruthenium, rhodium or iridium compounds from 1 M hydrochloric acid in the absence (empty sign, one-component solutions) and in the presence of sum of copper, cobalt, iron, nickel, magnum and chromium compounds, the concentration of each of them being equal 500 mg/l (filled sign, polycomponent solutions). The analogous results were obtained for all studied carbon materials. Some of them are presented in the table.

Table
Evaluation coefficients K for microamounts of palladium and ruthenium compounds from hydrochloric acid solutions ($m_{\text{coal}}=0.1\text{g}$, $C_{\text{PMC}}=1\text{ mg/l}$, $C_{\text{HCl}}=1\text{ M}$, $V_{\text{solution}}=10\text{ ml}$, $t=20^{\circ}\text{C}$, $\tau=240\text{ min}$)

PMC Coal	Pd		Ru	
	A	B	A	B
AA	100	100	100	100
AA-O	37	33	39	34
Coke	77	75	86	85
Coke-O	57	49	54	44
Sibunit	100	100	100	100

$K = 100 (C_0 - C_E) / C_0$, when C_0 and C_E - initial and equilibrium (after adsorption) concentrations of PMC in solution; A and B - one and polycomponent hydrochloric acid solutions.

To explain these results the possible mechanism of platinum metals sorption by carbon materials was examined. The metal adsorption by carbon materials seems to be carried out mainly through surface reactions with participation of carbon and surface functional groups as it can be concluded from the present knowledge, so this adsorption mechanism may include presumably the surface complex formation as well as ion exchange [1].

Platinum metals are known to form strong complex compounds with various ligands, including chelate ones. These complexes are capable to act as participants in reactions of exchange, oxidation-reduction, formation of polynuclear compounds and so on. Thus, platinum metal compounds may be adsorbed by carbon materials through different mechanisms: ion exchange, surface complex formation, reducing sorption and others [2-4]. We can not exclude any from them, especially the reduction sorption, that was found to be characteristic of palladium sorption by some coals [3]. However, the common mode of interaction between platinum metal compound and any from carbon materials must be supposed for explanation of independence of sorption selectivity on nature and composition of

carbon adsorbents. The carbon matrix is the only common property of all sorption materials under consideration. So, taking into account this fact and the complex-forming properties of platinum metals ions, the direct interaction between platinum metal and π -conjugated electron system of carbon matrix is supposed to take place. This direct interaction seems to be the main reason of carbon materials sorption selectivity of platinum metals extraction. That assumption may be confirmed by the fact that sorption capacity decreases when the value of functional groups on the carbon adsorbents' surface increases and this way the carbon matrix is screened for direct interaction with platinum metal compounds. So, the new functional groups are known to be formed on the surface of coals as a result of their oxidation [1]. The sorption capacity of oxidized forms of coals must be greater than unoxidized ones if the mechanism of adsorption includes the surface complex formation presumably. But as it is shown on figure and on the table, sorption capacity of oxidized forms of carbon materials (CFO, SKNO, AAO, Coke-O) is smaller than the same of their initial forms (CF, SKN, AA, Coke) for evaluation of all platinum metals to be study. The analogous results were obtained with other samples of modified coals.

From the other hand the largest value of sorption capacity for all investigated platinum metals was found for activated anthracite and for synthetic coal "sibunit"[4] which contain maximal values of carbon and minimum values of functional groups on their surfaces. So, these experimental results also corroborate assumption about direct interaction between platinum metal and carbon matrix as main reason of strong selectivity of carbon materials for platinum metals microamounts sorption.

Conclusions

The strong selective adsorption of mikroamounts of palladium, ruthenium, rhodium and iridium compounds from water solutions with complex composition by set of different carbon materials was found. The direct interaction between platinum metals and π -conjugated electron system of carbon matrix is proposed to be a main part of mechanism of adsorption of platinum metals by carbon materials and to explain independence of sorption selectivity on nature and composition of adsorbents.

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