

SORPTION OF PLATINUM METALS' COMPOUNDS BY CARBONS WITH DIFFERENT POROSITY AND SURFACE NATURE

I.A.Tarkovskaya, S.V.Rosokha, N.V.Kulik, S.S.Stavitskaya*, L.P.Tikhonova

Institute for Applied Problems in Physics and Biophysics of National Academy of Sciences of Ukraine, 252142, 3, Slyzhbova, Kyiv Ukraine

* Institute Sorbtion and Endoecology Problems of National Academy of Sciences of Ukraine

Introduction

The carbon materials (CM) were shown [1, 2] to be selective adsorbents for platinum group metals' (PMG) evaluation from different complex aqueous solutions including technological solutions of waste and sewage treatment. The influence of structure and nature of surface of CM on the sorption capacity and selectivity was not investigated systematically up to now, however. The presented previously data are limited and contradict [1,2]. The interest to the study of these factors is determined by possibilities of use of CM for platinum metals' evaluation from various solutions.

Experimental

The CM under study include natural (anthracite, longflame carbon "D") synthetic (SKN, SKNO, sibunite) and technical (SKT, BAU, DOU, KAU) carbons. The sorption capacity and selectivity were determined in static and dynamic conditions. The whole porous volume of CM was in the range 0,07 - 0,95 cm³/g, their specific surface 150 - 1000 m²/g. In order to find the effect of surface groups, the carbons with constant porous structure but different specific concentrations of oxygen-containing surface groups (from 0,01 to 2,2 mM/g) were used for investigations. The chloride acidic aqueous solutions containing chloride compounds of platinum metals (Ru, Rh, Pd, Ir, Pt) with different concentration (from 0.5 mg/l to 10 g/l) were the main objects of investigations. Two types of systems were studied: one-component solutions of chloride complexes of PGM and the same with 10-500-fold excess of commonly accompanying metals' ions (copper, iron, cobalt, nickel, manganese, chromium, aluminium, zinc). The concentrations of the platinum metals ions in the solutions were determined after 24 hours contact time (equilibrium concentration of the ions in the solutions was reached practically after 4 - 6 hours contact time). Platinum metals' ions were determined mainly spectrophotometrically [3].

Results and Discussion

The dependence of some platinum metal ions' sorption on the specific surface of CM (S) is presented

at Figure 1. The data obtained indicate the correlation between the changing of the sorption and specific surface. The coefficients of correlation are found to be 0.97 for palladium and 0.99 for rhodium.

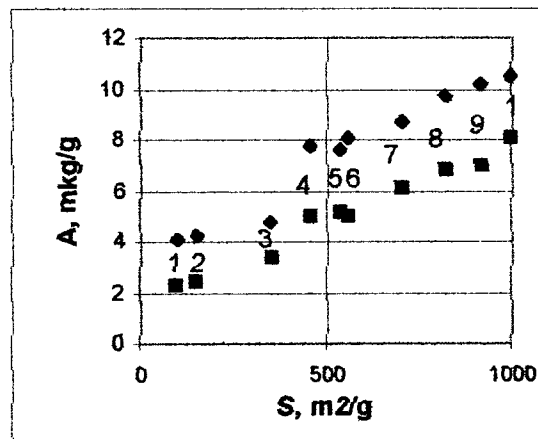


Figure 1. The capacity of the carbons concerning Pd (◆) and Rh (■): CM: 1- D, 2 - anthracite, 3 - activated anthracite, 4 - oxidised anthracite, 5 - activated chaircoil, 6 - BAU, 7 - SKT, 8 - SKNO, 9 - sibunite, 10 SKN.

Similar correlations are observed between the PMG sorption and whole porous volume (W_s). The dependence between the sorption capacities and the volume of different porous types (micro- and meso-) and also the micro-porous characteristics (the constants B of the Dubinin equation, the micro-porous half widths - x, nm) are less definite.

The presence of 500-1000-fold excess of accompanying unobtable metals effects slightly on the sorption of PGM ions as in static as in dynamic conditions. The selectivity of the platinum metal ions' sorption was found to be independent on the carbons' porous structure characteristics. The high sorption selectivity was observed for all CM under study including low-porous natural anthracite and coke. The selectivity coefficients (K_c) calculated as ratio of platinum sorption a_{pt} in multicomponent solutions to the value a_{lim} for platinum at the same equilibrium concentration in one-component solution were found to be 0.91-1.0 for different CM. The variation of the chemical nature (ion-exchange characteristics) of the

carbons has practically no effect on the selectivity also. The platinum metals' ions were extracted by oxidized carbons, as also by activated carbons without functional surface groups altho they are present in solutions mainly as anionic forms in the conditions under study (Figure 2).

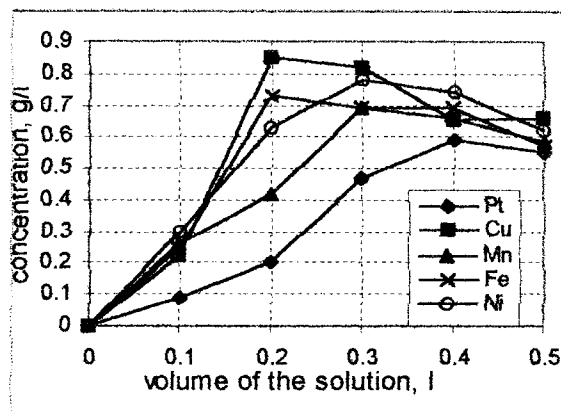


Figure 2. The dynamic sorption of the platinum ions by oxidised KAU. Initial concentration (g/l): Pt - 0.96, Cu - 0.9, Mn - 0.68, Fe - 0.71 - Ni - 0.63, HCl - 1 M.

However the whole capacity of CM concerning platinum metals' ions decreased with increasing of the quantity of the oxygen-containing functional groups at CMs' surface and their cation-exchange capacity (Figure 3).

The main reason of the high selectivity of the CM concerning PGM ions seems to be connected with the fact that, besides ion-exchange process, complex formation take place in this case [1,2]. These ions interact as with surface functional group and immediately with π -systems of carbon matrix, which could be considered as part of the ligand environment of the metal ions. Such interaction results in the partial (complex formation) or full (reduction of platinum ion to metallic state) electron transfer from the carbon to the platinum ion. These processes are unlikely for the complexes of un-noble metals and they are the reason of the absence of the concurrent sorption for the solutions with complex contents.

The above mentioned interaction is not related to the structural characteristics of the carbons directly. However the increase of the degree of activation of CM determines the enlargement of the specific surface and whole porous volume of the sorbent. It can promote the electron transfer processes at the surface (particularly by increasing of conductivity). The decrease of the PGM sorption with increase of oxygen containing functional groups may be explained as decreasing of accessibility of the π -systems for their interaction with metal ions and also by lowering of reducing ability of carbons and other

factors.

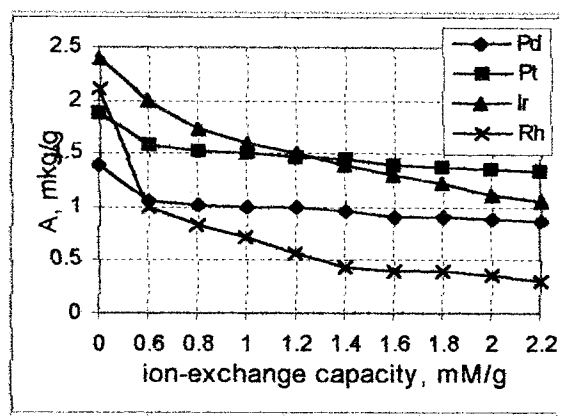


Figure 3. The dependence of the sorption on ion-exchange capacity. Initial concentration (mg/l): Pd - 20.4, Pt - 14.7, Ir - 95.5, Rh 98.5.

Thus the porous structure and the surface nature of the carbons effect significantly on the capacity of the CM concerning platinum metals' ions. At the same time these factors practically do not influence on the selectivity of the platinum metal compounds' sorption from complex systems. The generalities of the processes are connected with electron transfer at the carbon surface and peculiarities of the complex formation of platinum metals' ions with carbon surface. These facts may be useful for carbon sorbents preparation, which will be optimal in use for platinum metals' compounds extraction.

References

- [1] Tarkovskaya IA, Tikhonova LP, Tomashevskaya AN, Goba VE, Antonova LS, Svarkovskaya IP. Sorption of complexes of ruthenium, rhodium and palladium by the materials based on natural coals. *Russ. J. Phys. Chem.* 1996; 70(8): 1463-1457.
- [2] Tikhonova LP, Tarkovskaya IA, Rosokha SV, Kulik NV, Korovin YuF, Komarov VP, Kadochnikov VA. Selective sorption of platinum metals compounds by different materials *Russ. J. Applied. Chem.* 1998; 71(10): 1632-1637.
- [3] Ginzburg SI, Ezerskaya NA, Prokof'yeva IV. Analytical chemistry of platinum metals Nauka: Moscow. 1972.