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The Mechanism of Potential Shifts of Activated Carbon Due to Adsorption of Organic Compounds

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Shifts of potential on porous electrodes due to adsorption of inorganic compounds were first observed by A. Frumkin, *et al.* [1] and studied in detail on catalytically active metals of platinum group with formation of adatoms [2]. Such shifts also occur on other metal electrodes due to adsorption of organic compounds [3]. However, this phenomenon has not been sufficiently studied on porous active carbon electrodes, and the nature of the shifts is still unclear.

The main purpose of this work was to investigate the adsorption of certain organic compounds on activated carbon electrodes, depending on potential, in order to elucidate the mechanism of potential shifts due to adsorption (i.e., the difference between the initial and final potential of active carbon after adsorption).

Open circuit potentials of a granulated activated carbon adsorbent were measured against the Ag/AgCl reference electrode in the course of adsorption of albumin, acetone, sodium barbital (Medinal), and 2-propanol, with different initial concentrations of the adsorbates.

Potential shifts in the course of adsorption were observed for all of the above adsorbates with the exception of albumin. Fig. 1 shows the dependence of potential on time for the adsorption of Medinal on two active carbons and is characteristic for all adsorbates.

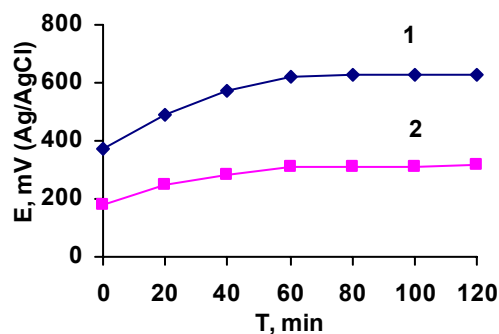


Fig. 1. Medinal adsorption on activated carbon: Open circuit potentials of activated carbon vs. time. 1- SIT-1, 2 -SKT-6A.

Table 1 shows the measured and calculated data on adsorption of the above adsorbates on activated carbon SIT-1. Again, the potential of activated carbon did not change during the adsorption of albumin, while the adsorption of other adsorbates lead to shifts of initial potentials towards more positive values. It is also noteworthy that the magnitude of the shifts depends on the degree of filling of active carbon surface.

**Table 1. Adsorption of organic compounds at activated

carbon SIT-1 (120 min).

Adsorbate	C_i , M	A_m , M/g	A_{calc} , M/g	Θ , %	ΔE , mV
Acetone	8.8×10^{-1}	7.7×10^{-3}	9.1×10^{-3}	85	145
2-Propanol	6.7×10^{-2}	8.3×10^{-4}	5.9×10^{-3}	14	20
Medinal	2.4×10^{-2}	3.6×10^{-4}	5.2×10^{-4}	75	101
Albumin	5.0×10^{-6}	3.0×10^{-8}	3.6×10^{-5}	10^{-2}	0

** C_i - initial concentration of adsorbate, A_m - measured values of adsorption, A_{calc} - adsorption values calculated for monolayer filling, Θ - percentage of adsorbent surface covered by adsorbate.

Based on these data, one can suggest that desorption of the adsorbates from activated carbon should lead to a reversal of potential shifts towards more negative values. Moreover, the magnitude of such shifts should correlate with the desorbed amount (washed out).

To test the above hypothesis, an attempt was made to eliminate the adsorbed compounds from the surface of activated carbon. Open circuit potential of the adsorbent was taken during the elimination. Desorption of the adsorbates from activated carbon by washing with water was observed for all compounds except albumin, which did not show any appreciable desorption. Moreover, the degree of elimination was different for all adsorbates.

It was found that the elimination of adsorbates from the adsorbent leads to reverse shifts of the potential towards more negative values. The magnitude of such reversals was shown to correlate with the amount of adsorbate eliminated. For example, eliminating 47% of adsorbed acetone on the surface of SIT-1 adsorbent led to a reverse potential shift of 53%; eliminating 41% of acetone off the SKT-6A adsorbent, to a reverse shift of 50%; eliminating 98% of 2-propanol off the SIT-1 adsorbent, to a reverse shift of 132%.

Thus, it was shown that the magnitude of potential shifts is directly related to the degree of filling of active carbon surface. It should be emphasized that the adsorption-desorption data confirmed the qualitative dependence of potential shifts of active carbon on the degree of filling of the adsorbent surface.

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