

CHARACTERIZATION OF EXHAUSTED CARBONS USED FOR AIR PURIFICATION IN SEWAGE SYSTEMS

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Introduction

Activated carbon has been used for the adsorption of pollutants for many years. One of its main environmental application is sorption of H_2S and other odorous compounds from sewage systems [1].

Activated carbons used for air purification in sewage treatment plants are mainly caustic. In spite of high H_2S breakthrough capacity ($>0.12 \text{ g/cm}^3$) they create the risk of self-ignition due to the presence of NaOH or KOH. When their life time as sorbents of hydrogen sulfide and other vapors present in sewage systems (mercaptans, volatile organic compounds) is over, the problem of regeneration or reactivation of used material arises.

Experimental

The carbons previously used for air purification in Wards Island Water Pollution Control Plant having pH (evaluated according ASTM D 3838) 2.4, 6.3, and 10.2 were chosen for this study. Samples taken directly from the plant vessels are designated as C-A(V), C-B(V) and C-C(V) respectively. Carbons dried after standard ASTM procedure of pH evaluation are referred to as C-A(pH), C-B(pH) and C-C(pH) (after pH washing). As a final step the samples were washed out to constant pH (C-A(N), C-B(N) and C-C(N)).

The pH of carbon surface was evaluated according to ASTM D 3838 standard procedure. Nitrogen isotherms were measured using a ASAP 2010 (Micromeritics) at 77K. Thermal analysis was carried out using TA Instruments Thermal Analyzer. Potentiometric titration measurements were performed with a DMS Titrino 716 automatic titrator (Metrohm). The instrument was set at the mode when the equilibrium pH was collected.

Results and Discussion

The data obtained from the analysis of nitrogen adsorption isotherms are collected in Table 1. The surface area, S, and micropore volumes, V_{mic} , of our carbons are relatively small due to the deposited sulfur, its compounds, and other species.

The surface chemistry of carbons was evaluated from potentiometric titration [2-4]. For data treatment the SAIEUS numerical procedure [5] was used.

Changes in surface chemistry of our carbons upon washing are shown in Figures 1 and 2. In the case of the most acidic carbon, C-A, washing caused a significant decrease in the number of acidic groups. Complete washing changes the surface more drastically. The total number of groups significantly decreased and now the surface consists only of insoluble compounds or compounds bound to the carbon matrix. [6,7].

Table 1. Structural parameters

Sample	S[m ² /g]	V _{mic} [cm ³ /g]	S _{mic} [%]
C-A(V)	307	0.050	36
C-A(N)	266	0.045	34
C-B(V)	471	0.099	50
C-B(N)	356	0.070	45
C-C(V)	272	0.045	32
C-C(N)	318	0.050	29

For the most basic carbon, C-C, pH washing results in a significant decrease in the number of groups represented by a big peak at pK_a about 7 (H_2S , H_2SO_3) and groups having pK_a higher than 9 which we assume are responsible for high pH of this material. Complete washing causes in the removal of some species at pK_a larger than 7 and a complete resolution of groups having pK_a in strongly acidic range of our experimental window.

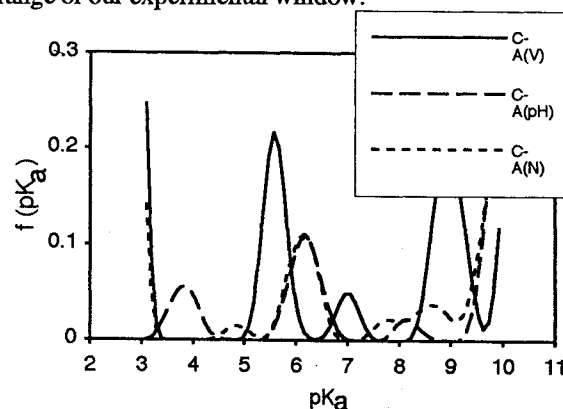


Figure 1. pK_a distributions for A carbons.

Comparison of the distributions obtained for carbons after washing to constant pH, (N), indicates the presence of different chemical inventory (Fig. 3). Carbon A has the pK_a s of its surface compounds

mainly higher than 6. Carbon B is characterized by heterogeneous surface and its deposited compounds cover almost whole experimental window, whereas carbon C has the majority of its species at the range of $pK_a < 6$. This is an interesting observation since the initial pH of this sample was basic. It is likely that the residual presence of caustic material might contribute to this value.

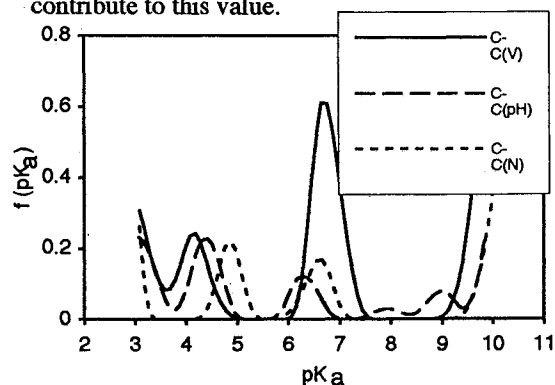


Figure 2. pK_a distributions for C carbons

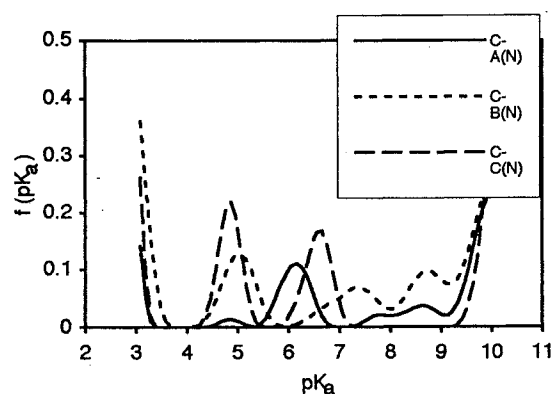


Figure 3. pK_a distributions for N carbons

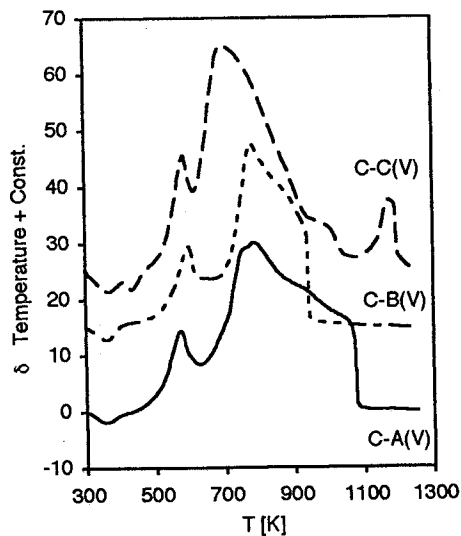


Figure 4. DTA curves for V carbons (in air)

The influence of surface chemistry on ignition temperature of our carbons can be evaluated using thermal analysis. DTA curves for V and N carbons are presented in Figures 4 and 5. The biggest exotherm represents the ignition of carbonaceous material. The presence of basic compounds and salts leads to lower ignition temperature whereas after washing the relationship is reversed; the most acidic carbon (C-A(N)) with the lowest deposition of insoluble compounds has the lowest ignition temperature.

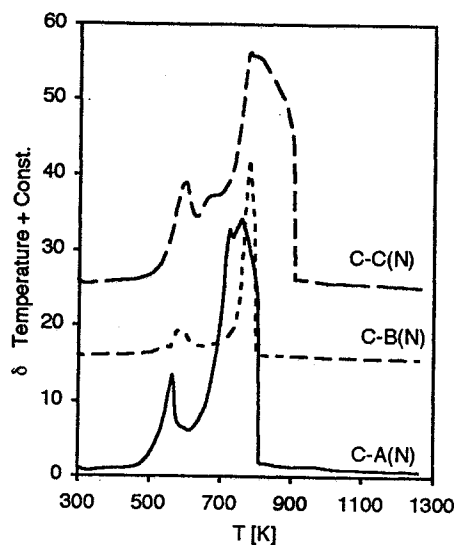


Figure 5. DTA curves for N carbons (in air)

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