

ELECTROCHEMICALLY MODIFIED ACTIVATED CARBON FOR INCREASING THE AMOUNT OF ION EXCHANGE PROPERTIES

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Introduction

Activated carbons are considerable interest from the high adsorbent materials community, since they have initially developed for the separation and purification of gases, liquids and solids. The porous structure, shape and surface area of carbon adsorbents are dominant parameters in the superior adsorption behaviors [1,2]. However, the adsorption of polar inorganic molecules, such as heavy metals or radionuclides, on activated carbons from aqueous solutions, is more depended on the quantity and the nature of the surface complexes, than on the surface area and the porosity of carbon adsorbent. It is well known that the adsorption properties of activated carbons are mostly influenced by the presence of surface oxygen groups. Depending upon conditions, they may enhance the adsorption of cations and/or anions from aqueous solutions [3].

The objective of the present work is to study the effect of anodic surface treatment of activated carbon on adsorption properties in a very simple procedure, and to investigate the role of surface functional groups created after anodic treatment with a viewpoint of the ion exchange properties of activated carbons.

Experimental

The porous activated carbons (ACs, 8×12 mesh) based on coconut shell were subjected to electrolytic reaction in

an aqueous solution of 35 wt% NaOH with 0.3, 0.6, 1.5 and 3.0 A of current intensities for each 60 sec. at 25 °C. Electrolytic oxidation was performed in the batch system, where ACs on the graphite bath filled with the electrolyte were fixed on graphite anode roller. A cathod graphite plate was also submerged in the electrolyte solution.

The nitrogen adsorption isotherm for BET surface areas and pore volumes was measured at 77K using the volumetric method (Micromeritics, ASAP 2400).

The surface pH of ACs was measured with ASTM method. Acid and base values on the surface functional groups of the samples were determined by using a titration technique of Boehm on the basis of adsorption of 0.1N NaOH and 0.1N HCl standard solutions.

The measurement of ion exchange capacity was carried out by dry weight capacity (DWC) technique.

Results and Discussion

Table 1 shows the experimental surface properties and adsorption surface characteristics of the ACs modified by anodic treatments as a function of current intensity. The surface pH of ACs gradually increases as increasing the current intensity. The result of acid and base values measured by a titration technique show that the surface of AC untreated is amphoteric, with a slight excess of basic properties, and increasing of current intensity of the ACs leads to more increase of base value rather than acid one. These results indicate that the anodic treatment in NaOH

Table 1. Surface and adsorption characteristics of the activated carbons studied

Current intensity (A)	pH	Acid value (mequiv·g ⁻¹)	Base value (mequiv·g ⁻¹)	BET surface area (m ² ·g ⁻¹)	Total pore volume (cm ³ ·g ⁻¹)	Micropore volume (cm ³ ·g ⁻¹)	Average pore diameter (Å)
0	7.8	123	227	1186	0.495	0.457	16.7
0.3	8.0	125	244	1163	0.478	0.448	17.4
0.6	8.0	132	277	1096	0.447	0.421	17.3
1.5	8.3	142	355	1115	0.458	0.429	17.6
3.0	8.5	164	383	1100	0.457	0.423	17.4

electrolyte makes an important role in increasing the basic (or electron donor or anion-rich) properties of ACs, and the base value is greatly correlated with the surface pH of the ACs measured.

The surface characteristics of the ACs studied shows that all of the samples possess a well-developed micropores with diameters $< 20 \text{ \AA}$, and similar surface and pore structures being approximately Type I according to the BET classification, as seen in Figure 1. However, adsorption, such as BET surface area, total pore volume, and micropore volume tends to slightly decrease with increasing current intensity. It may be considered by two folds: The first suggests that the widespread presence of surface functional groups due to anodic treatment on virgin ACs can be attributed to the diminution of attraction between nonpolar N_2 adsorbate and polar adsorbent. The second is explained by which micropore structures of intrinsically basic-rich ACs are etched by somewhat increasing of acidic oxide functional groups (or acid value as shown in Table 1) formulated from the hydroxyl, phenol, carbonyl, carboxyl groups produced by NaOH degradation.

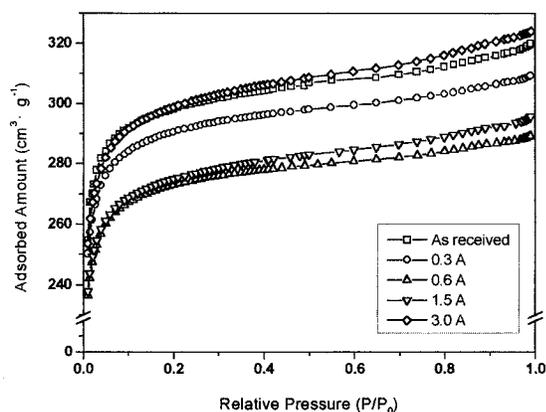


Figure 1. N_2 adsorption isotherm of activated carbons with relative pressure.

While, it is well known that nature of surface functional groups on a solid matter can have a marked effect upon high selectivity causing not only adsorption but also ion exchange reaction described as the reversible interchange of ions between a solid phase and a liquid phase. The ion exchange behaviors on activated carbon anodized as a function of current intensity are shown in Figure 2. As a result, both of cation and anion exchange capacities of the ACs studied are increased in increasing the current intensity. And, anodically treated AC is more effectively

evaluated on cation exchange capacity than on anion exchange capacity in this experimental conditions. This behavior may be explained by the increased degree of acid and base values. This acid-base contribution to the work of ion exchange capacity can be related to the interface study of acid-base pairs and the degree of acid-base interaction at interface between ACs and solute (or adsorbate).

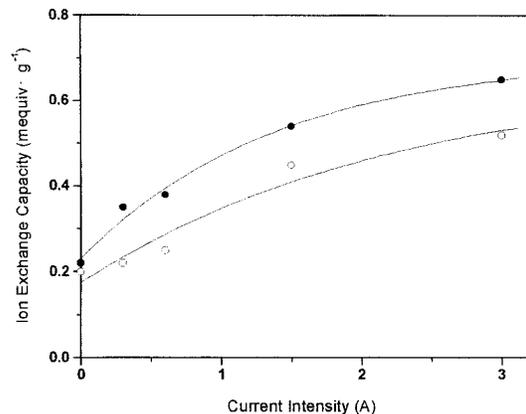


Figure 2. Variation of the anion exchange capacity (O) and cation exchange capacity (●) of the ACs studied.

Conclusion

The anodic surface treatment of activated carbons leads to an increase in the surface functional groups without significant changing of surface and pore structures. As a result, the surface functional groups on activated carbon anodized can very appreciably enhance the degree of ion exchange capacity on a solute of opposite surface polarity based on acid and base properties. On the basis, it can be concluded that anodic treatment of activated carbon can be utilized to develop more selective and effective adsorbents including ion exchange capacity for gas and liquid purification control.

References

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