STRUCTURES AND ADSORPTION PROPERTIES OF PITCH-BASED ACTIVATED CARBON SPHERES

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Introduction

Because of their excellent performances, pitch based activated carbon spheres(PACS) has been successfully used in many important fields such as environmental protection, medicine, and military equipment(1-5).
In the present paper, coal-tar pitch-based activated carbon spheres (PACS) were prepared through steam activation(4). The functional groups on the surface of PACS were characterized XPS in detail, and adsorption properties of PACS were also investigated preliminarily.

Experimental

A coal-tar pitch with the softening point of 70℃ was chosen as the raw material and oxidized under air-blowing into a poly-condensed pitch with the softening temperature about 250. The resultant coal tar pitch was mixed with an aromatic solvent homogeneously at 170 ℃ . After cooled, the mixture was pulverized into a definite size and spherulitized using the method of emulsification. The pitch spheres were oxidatively stabilized in air in a fixed bed reactor, and then carbonized and activated in a fluidized bed reactor using water vapor as the activating agent at 900℃.
The surface area, and pore structure of PACS were measured by nitrogen adsorption (at 77K) using ASAP2000 adsorption apparatus.
Surface chemical structures of carbonaceous materials were investigated by X-ray photoelectron spectroscopy (XPS). XPS measurements were carried out on a PHI-5300 ESCA(Perkin-Elmer) using Mg K α X-rays of energy of 1256.3ev at a power of 250W (12.5KVx20mA) in vacuum of 10^{-8} torr.

Results and Discussion

General properties of PACS
General properties of PACS, including diameter,spheroidicity,elemental analysis,porous stuctural parameters, were summarized in Table 1. PACS have good spheroidicity(>0.95), high carbon content(>95wt%) ,low ash, high surface area(>1000m²/g), and abundant porous structures.

Surface chemical properties of PACS
Surface chemical properties of activated carbons are related to the presence of chemical groups analogous to the functional groups of organic compounds, and affect in a decisive manner the ion-exchange, catalytic, electronic, and adsorption properties of activated carbons(6). XPS surface analysis of Sample C were listed in Table2. It contains different oxygen-containing functional groups, which can tentatively attributed to C-O (ether/hydroxyl,16%), C=O (lactone, carbonyl, 5%), and COOH (carboxylic anhydride, 4%) functionalities, respectively.

Adsorption properties of PACS
Adsorption properties of PACS were shown in Table 3. PACS have excellent adsorption properties. Adsorption capacities of PACS to Benzene, Tetrachloride Carbon, and Iodine are about 380-570mg/g, 700-970mg/g, and 1200-1630mg/g, respectively. The adsorption capacities of PACS to Vitamine B_{12} is about 70-94%.

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Table 1 General properties of PACS

Sample	Diameter mm	Spheroi-dicity	Elemental analysis(wt%) C	H	O+N	S	Ash	SBET m^2/g	Smicro m^2/g	Vtotal ml/g	Vmicro ml/g
A	0.15-0.35	0.96						932	750	0.40	0.26
B	0.35-0.45	0.96						1380	917	0.64	0.34
C	0.60-1.00	0.96	96.8	0.9	1.1	0.4	0.6	1290	743	0.62	0.33

Table 2 Results of XPS measurements of sample C

Band Name	C=C	C-H	C-O	C=O	O=C-O	C-X
Peak Position,ev	283.95	284.60	286.10	287.60	289.10	290.60
Delta, ev	0.00	0.65	2.15	3.65	5.15	6.65
Area, ev/s	55448	28295	20088	6623	5017	4226
% of Total Area	46.32	23.64	16.78	5.53	4.19	3.53

Table 3 Adsorption properties of PACS

Sample	Diameter mm	Surface area m^2/g	Adsorption capacity(mg/g) C_6H_6	CCl_4	I_2	Adsorption capacity(%) B_{12}
D	0.15 -0.35	1012	381	708	1225	70.3
E	0.15-0.35	1357	520	887	1406	
B	0.35-0.45	1380	527	904	1470	
C	0.60-1.00	1290	483	852	1364	94.5
F	0.60-1.00	1555	575	978	1638	