A COMPARISON OF THE MICROPORE STRUCTURE OF ACTIVATED CARBON FIBER WITH DIFFERENT CO_2 ACTIVATION

Zheng-Hong Huang, Feiyu Kang, Jun-Bing Yang and Kai-Ming Liang
Department of Materials Science and Engineering, Tsinghua University
Beijing 100084, P. R. China

Introduction

Activated carbon fibers (ACF) are widely used for separation and purification of gases because of its abundant porous structure. Porosity in ACF is determined by the activation process and precursor material [1]. The type of porosity created by gasification also depends on the CO/ CO_2 ratio [2]. Direct activation with CO_2 may produce activated carbon [3,4]. The present work prepared ACF with CO_2 by different process and characterized them by nitrogen adsorption at 77 K.

Experimental

Strips of viscose rayon was first soaking in aqueous solutions containing 5% $(NH_4)_2HPO_4$ for 10 minutes and then dried at 110 . The treated fabrics were divided into three groups which were prepared as follows: (i) Two strips were directly activated with 200 ml/min CO_2 at 850 for different duration, using heating rate of 5 /min; (ii) Two strips were carbonized in 200 ml/min N_2 at 5 /min with a residence time of 1 hr at 850 and then activated with 200 ml/min CO_2 at 850 for different duration; (iii) Two strips were carbonized as (ii) and then activated with 200 ml/min CO_2 and 10 ml/min CO at 850 . The pore structure of samples was characterized by N_2 adsorption at 77 K.

Results and Discussion

Table 1 lists the details for preparation of ACF. The overall yield of ACF decreased with hold time due to the burn-off reaction between carbon and carbon dioxide. The directly activated process took place faster than the char activation. However, the activated process with addition of CO slowed down at the same temperature. Nitrogen adsorption isotherms of ACF samples at 77K are shown in Fig.1. All samples exhibit type I isotherm, which are the typical adsorption characteristics of microporous materials. The plateau of isotherms became closer for higher burn-off. For all the three process the BET surface area and micropore volume increased with increasing burn-off, corresponding to increasing median micropore size. Pore development during direct activation results from by both pyrolysis and reaction between carbon and carbon dioxide gas. The results of nitrogen adsorption show that ACF prepared by direct process possessed wider microporosity. It is noted that the median micropore size of sample C1 is the smallest and the micropore volume is the highest. Thus, the addition of CO inhibited the gasification reaction and promoted the development of narrow microporosity. This effect weakened with time. It is seen that the micropore volume of sample C2 was lower than that of B2. However, it is surprising to see from Fig.2 that there is a higher peak for C2 in H-K micropore size distribution.

Conclusions

Viscose rayon based ACF prepared with different CO_2 activation exhibited different microporisity. Direct activation with CO_2 can produce wider microporisity. Addition of CO inhibited the gasification reaction and promoted the development of narrow microporosity.

References

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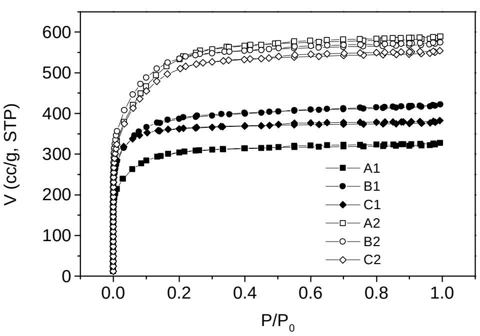

Fig.1 Nitrogen adsorption isotherms of samples at 77 K

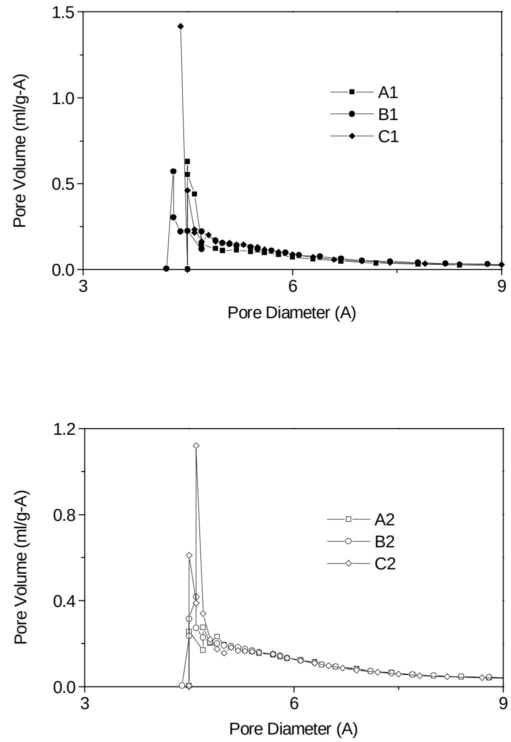

Fig.2 Ultramicropore size distributions of samples

Table 1 Details for preparation of ACF samples

Sample	Carbonization	Activation Gas	Activation Time (min)	Overall yield (%)
A1	No	CO_2	30	16
A2	No	CO_2	60	10
B1	1 h	CO_2	28	17
B2	1 h	CO_2	60	13
C1	1 h	CO_2/CO	30	18
C2	1 h	CO_2/CO	65	12

Table 2 Pore structure characteristics of ACF samples

	S_{BET} (m^2/g)	$S_{mi}(t)$ (m^2/g)	$V_{mi}(t)$ (cm^3/g)	V_{DR} (cm^3/g)	E_0 (kJ/mol)	H-K Median Pore Diameter (A)
A1	1042	630	0.288	0.404	20.3	6.1
A2	1905	582	0.239	0.656	18.0	6.9
B1	1326	920	0.422	0.524	20.4	6.1
B2	1847	933	0.420	0.689	18.9	6.6
C1	1218	982	0.457	0.524	22.1	5.6
C2	1783	743	0.324	0.644	18.2	6.8