STUDY ON ADSORPTION ABILITY OF PITCH-BASED SPHERICAL ACTIVATED CARBON WITH DIFFERENT PORE SIZE DISTRIBUTION

Zhichang Liu **Licheng Ling* **Yanzhen Fan* *Lang Liu*
Institute of Coal Chemistry, Chinese Adademy of Siciences,
P.O. Box 165, Taiyuan, Shanxi, China 030001
**State Key Laboratory, Institute of Coal Chemistry, Chinese Adademy of Siciences,*
P.O. Box 165, Taiyuan, Shanxi, China 030001

Introduction

Activated carbon, especially the spherical activated carbon, has been used widely in clinical medicine for its high adsorption capacity [1], removing toxic substances such as creatinine, uric acid, medium molecular substance, bilirubin etc.. In this paper, the adsorption ability of pitch-based spherical activated carbon (PSAC) with different pore size distribution to creatinine and vitamin B_{12} (VB_{12}), which are representative of the small molecular substance and medium molecular substance, was investigated.

Experimental

Three kinds of PSACs, PSAS with micropore mainly (PSAC-W), PSAC with both micropore and mesopore (PSAC-WZ) and PSAC with high ratio of mesopore (PSAC-Z), were prepared according to articles reported elsewhere [2-4]. The BET surface area and pore structure of PSACs were determined by nitrogen adsorption (77K) on ASAP2000 (Micrometritic Co. USA). The adsorption isotherm and dynamic adsorption curves of PSACs to creatinine and VB_{12} were respectively determined at 37±1°C. Ultraviolet-visible spectrophotometer (UV-Vis 7550, HP Shanghai Co.) was used to investigate the concentration of creatinine (234*nm*) and VB_{12} (361*nm*).

Results and Discussion

Table 1 shows BET surface area and pore volume of PSAC-W, PSAC-WZ and PSAC-Z. BET surface area of PSAC-W and PSAC-WZ were much higher than that of PSAC-Z, while the mesopore volume and mesopore ration of PSAC-Z was largest.

Fig. 1 is the adsorption isotherm of vious PSACs to creatinine. All the three adsorption isotherms belonged to Langmuir type. The adsorption capacity to creatinine was in the order of PSAC-WZ>PSAC-W>PSAC-Z, which is in the same order of the BET surface area. The molecular size of creatinine was small (0.54*nm*), it can be adsorbed in micropore easily. Therefore, the adsorption capacity to creatinine increased with the increase of BET surface area (Fig.1). The creatinine molecules diffused in mesopore more easily than that in micropore, resulting in taking less time to get to the adsorption equilibrium (Fig. 2).

Fig. 3 illustrates the adsorption isotherm of PSACs to VB_{12}. It can be seen that only the adsorption isotherm of PSAC-Z got to the equilibrium in this study, the others increased with the concentration of VB_{12}. The adsorption capacity of PSAC-W was the least. The adsorption capacity of PSAC-WZ was less than PSAC-Z when the concentration of VB_{12} was lower than 160*mg/l*, while it can go beyond the PSAC-Z's when the concentration of VB_{12} overed 160*mg/l*. Fig.4 shows the dynamic adsorption of PSACs to VB_{12}. The results indicated that the adsorption rate of PSAC-W was the slowest and did not reach the adsorption equilibrium even the adsorption time was over 360min. The adsorption rate of PSAC-Z was the fastest and it took the shortest time to get to the adsorption equilibrium. The above phenomena can be explained by the difference of pore structure of PSACs. The molecular size of VB_{12} (2.09*nm*) was larger than creatinine, it is diffcult to be adsorbed in micropore (<2.0*nm*) while can adsorbed in mesopore (>2.0*nm*) effectively. So, the adsorption capacity of PSACs to VB_{12} increased with the increase of mesopore volume. Also, the molecules of VB_{12} could diffuse in mesopore freely, leading to higher adsorption rate when there were more mesopores in PSAC.

Conclusions

To the small molecular substance (creatinine), the adsorption capacity increased with the BET surface area of PSACs. But to the medium molecular substance (VB_{12}), the adsorption capacity increased with the mesopore volume of the PSACs. Both to creatinine and to VB_{12}, the adsorption rate increased with the ratio of mesopore in the PSACs.

References

1. Kakazu T, Okawa K and Maeda T. Activated carbon as adsorbent for artificial kidney. Jpn Patent 02213357,1990.
2. Liu Z, Ling L. Qiao W and Liu L. Preparation of pitch-based spherical activated carbon with developed mesopore by the aid of ferrocene. Carbon, 1999;37(4):663-667.

3. Liu Z, Ling L, Qiao W and Liu L. Effect of hydrogen on the mesopore development of pitch-based spherical activated carbon containing iron during activation by steam. Carbon (in press).

Table 1. BET surface area and pore volume of PSAC-W, PSAC-WZ and PSACZ

Sample	BET (m^2/g)	Total volume (cm^3/g)	Microopore volume (cm^3/g)	Mesopore volume (cm^3/g)	Mesopore Ratio* (%)
PSAC-W	1450	0.50	0.34	0.16	32
PSAC-WZ	1500	0.89	0.24	0.65	73
PSAC-Z	372	1.15	0.08	1.07	93

*: Obtained from the ratio of mesopore volume to total pore volume.

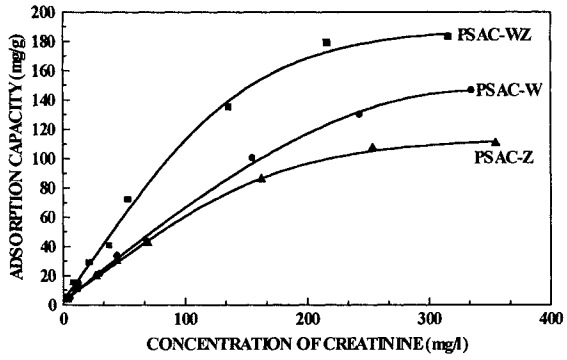

Figure 1. Adsorption isotherm of PSAC-W, PSAC-WZ and PSAC-Z to creatinine

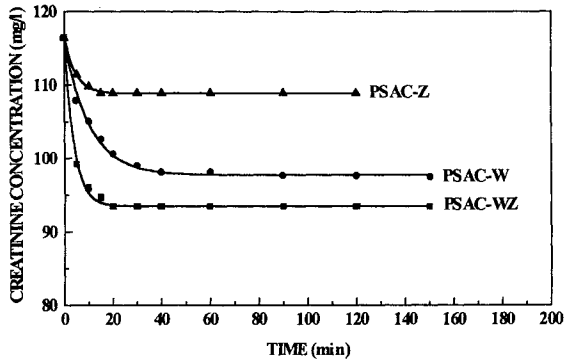

Figure 2. Dynamic adsorption curves of PSAC-W, PSAC-WZ and PSAC-Z to creatinine. Original concentration of creatinine: 116mg/l.

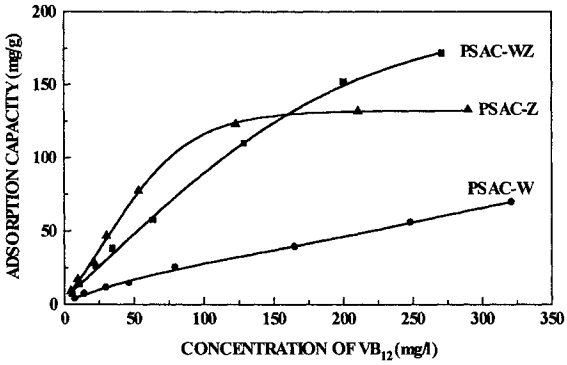

Figure 3. Adsorption isotherm of PSAC-W, PSAC-WZ and PSAC-Z to VB_{12}.

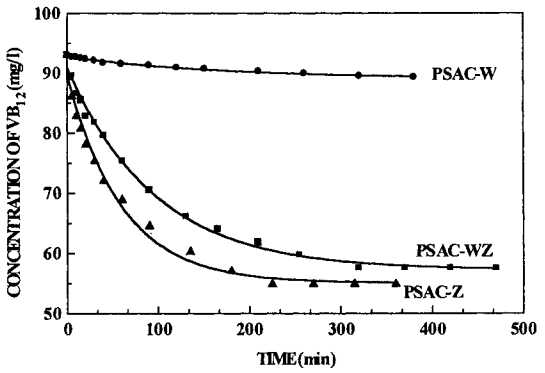

Figure 4. Dynamic adsorption curves of PSAC-W, PSAC-WZ and PSAC-Z to VB_{12}. Original concentration of VB_{12}: 93mg/l.