TEXTURAL CHARATERISTICS OF ACTIVATED CARBON FIBERS BY PHYSICAL ADSORPTION OF GASES

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Introduction

Activated carbon fibers have important commercial uses for the seperation of organics molecules from air and water streams. The use of carbon molecular sieve in gas seperation has attracted increasing attention.[1] These carbon fibers are characterized by a high adsortion capacity, the volume of micropores, their size distribution and by dimension of their micropore openings, which must be close to those of the potential adsorptives.[2,3] Depending on the respective micropore dimensions of activated carbon fiber, the rates of diffusion of a given gas molecule are affected considerably.[4]

The present paper deals with the preparation and properties of activated carbon fibers obtained from pitch and PAN fibers activated with steam. The adsorption capacity and molecular sieve properties of the activatel carbon fibers were investigated by gas adsorption of various gas molecular dimensions

Experimental

Starting from a isotropic petroleum pitch, pitch fibers have been obtained by spinning at 300℃. The pitch fibers were stabilized at atmosphene for heating at 1℃/min to 280℃, holding time for 1hr. After that, the pitch fibers carbonized in N_2 for 1/2h at 1000℃ but the PAN fibers carbonized were used raw material. The activation of carbon fibers (5g of sample in each experiment) was made at 800, 850, 900℃ with steam / N_2 mixture in a horizental furnance.

The surface area of the fiber before and after various treatments was measured by adsorption of nitrogen at 77K using a Quantachrome Autosorb. Elemental analysis was carried out with a YANACO CHN CODER MT-3 elemental analyser. For each adsorption experiment, a carbon fiber of 0.5g was filled into U-quartz tube which had an inner diameter of 18mm. The U-quartz tube was set on a digital balance in order to continuously record the sample weight changes. Air as carrier gas and diluted mixing gas(adsorptives/air) possesing adsortives of different critical dimensions such as benzene, carbon tetrachloride and methanol were used at 293 K.

Result and Discussion

Fig.1 illustrates adsorption profiles of benzene (C_6H_6) and carbontetrachloride(CCl_4) on activated carbon fibers at room temperature(20℃). In the figures, 850-5-1 mean activating temperature(℃)-flow rate of steam(5; =58ml/hr) -reaction time(hr). The critical dimensions of benzene, carbontetrachloride and methnol molecule are 0.41nm, 0.63nm and 1.23nm, respectively

Activated carbon fibers adsorbed both C_6H_6 and CCl_4 very rapidly with 10 min, where adsorption of C_6H_6 and CCl_4 were essentially saturated. For the activated carbon fiber which was prepared by the same activating conditions, after 10 min, the adsorption selectivity of CCl_4 was about two times than that of C_6H_6, exhibiting similar profiles, respectively.

However. we have obtained quite different results for methanol(CH_3OH) compared to the above adsorptives as described in Fig. 1. Activated carbon fibers adsorbed CH_3OH within 5 min, where adsorption of CH_3OH were saturated. But the activated carbon fiber which was prepared by different activating conditions showed the same adsorption profiles.

As described in Fig.2, the adsorption capacity of C_6H_6, CCl_4 over activated carbon fibers increased with burn-off, but in case of CH_3OH, showed independent with burn-off because of pore size distribution of activated carbon fibers and the critical dimension of C_6H_6, CCl_4 and CH_3OH molecule.

Moreover, figures above mentioned were described the relationship between pore development in activated carbon fiber according to evolution of activation and the adsorpion of adsorptives molecules possesing different critical dimensions. Activation process in carbon fibers indicated pore development occurred by a focused attack on pore smaller than 0.5 nm, creating pores in the 0.5 ~ 1nm range. So, the activated carbon fiber had uniform pores of 0.5~1nm range. Therefore, in the separation of gases, the adsorptive molecules(C_6H_6, CCl_4) with a kinetic diameter smaller than the average pore size rapidly diffuse into the micropore volume, while the adsortion of larger molecules(CH_3OH) is much reduced.

Conclusion

The activated carbon fibers for separation of organics molecules from air and water streams are characterized by a high adsortion capacity and by dimensions of their micropore, which must be close to

those of the potential adsortives.

It is explained that the relationship between pore development in activated carbon fiber according to evolution of activation and the adsorpion of adsorptives molecules possesing different critical dimensions. The activated carbon fiber had uniform pores of 0.5~1nm range. Therefore, the adsorptive molecules(C_6H_6, CCl_4) with a kinetic diameter smaller than the average pore size rapidly diffuse into the micropore volume, while the adsortion of larger molecules(CH_3OH) is much reduced.

References

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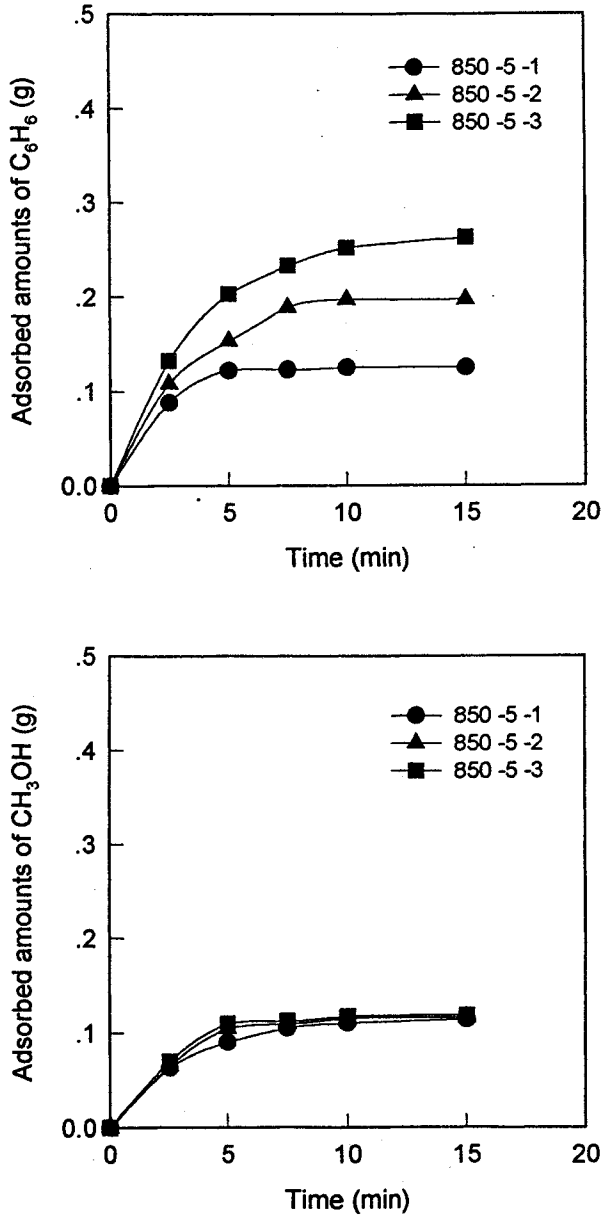

Fig. 1. Adsorption profiles of C_6H_6, CCl_4 and CH_3OH on activated carbon fibers at 20℃.

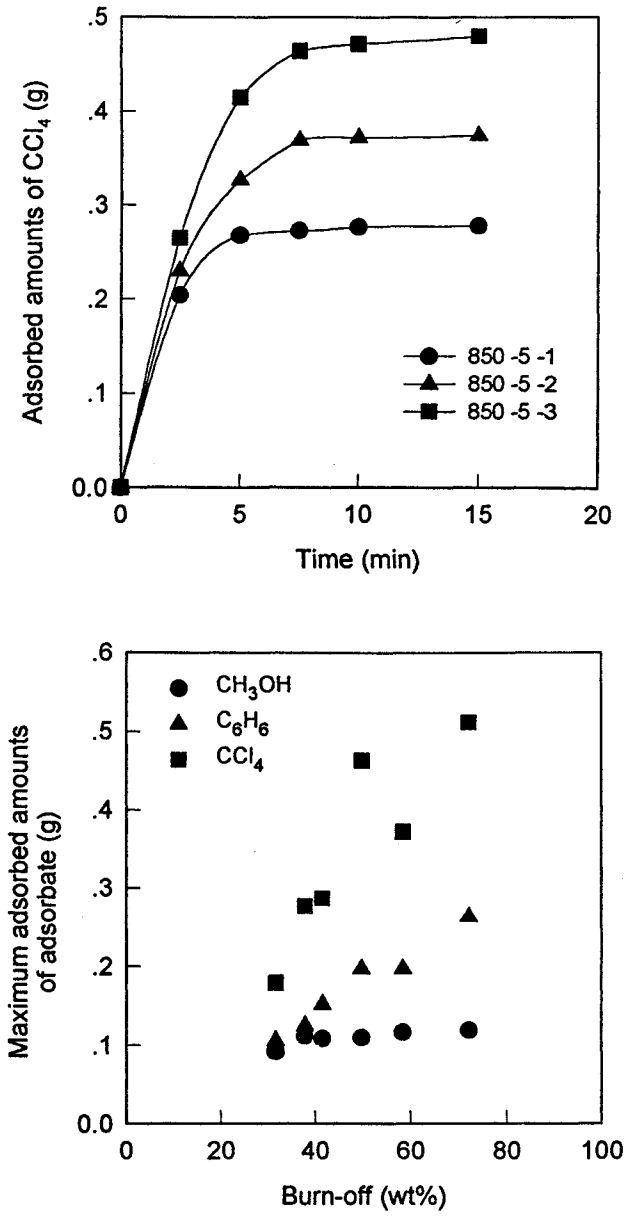

Fig. 2. Maximum adsorbed amouts of adsorbative vs. burn-off of activated carbon fibers.