POSTER

ADSORPTION AND DESORPTION OF H_2O OVER ACTIVATED CARBON FIBERS

Yuji Kawabuchi, Shizuo Kawano, and Isao Mochida
Institute of Advanced Material Study, Kyusyu University,
6-1 Kasuga Kohen, Kasuga, Fukuoka, 816, JAPAN

INTRODUCTION

Pitch and polyacrylonitorile (PAN) based activated carbon fibers have been commercialized as a unique adsorbent for various application because of its surface functional groups and pore structure [1, 2] . Its pore developed in the fiber surface allows rapid adsorption and desorption [3] . The desorption can be achieved at lower temperature by controlling its surface structure. Hence, they can be applicable as an efficient desiccant by controlling its surface groups.

In the present study, two types of activated carbon fibers (pitch and polyacryronitrile based) are examined in terms of H_2O adsorption and desorption. Since oxygen functional groups on the carbon surface are believed to be responsible for its properties in adsorption and desorption, relations of between H_2O adsorption and desorption ability and surface oxygen functional groups over ACF were studied.

EXPERIMENTAL

Three commercial activated carbon fibers (Pitch-ACF, PAN-1-ACF, and PAN-2-ACF) used in the present study are listed in Table 1 along with some of their physical and chemical properties.

The adsorption of H_2O was carried out gravimetrically at 303K using a micro balance. H_2O vapour was supplied by a micro feeder into carrier gas of He. Both rates of H_2O supply and carrier gas were controlled to change the relative humidity.

H_2O breakthrough curves were also measured at 303K by a fixed bed flow reactor. H_2O concentration in the inlet was fixed at 80% of relative humidity (rh). H_2O concentration at the outlet was analyzed by a humidity sensor.

RESULTS

Figure 1 illustrates the adsorption isotherms of H_2O over Pitch, PAN-1, and PAN-2 ACFs at 303K. Pitch and PAN-2 ACFs showed S-shaped isotherms, adsorbing 30 and 50mgH_2O/g at 30% (rh), 200 and 280mgH_2O/g at 100% (rh), respectively. Rapid increase of adsorption was observed in the range of 30 to 60% (rh). In contrast, PAN-1-ACF exhibited a Langmuir type isotherm, apparent saturation of adsorption being observed at 40% (rh) where 130mgH_2O/g was adsorbed. The significant adsorption at lower humidity should be noted.

Figure 2 illustrates adsorption isobar over PAN-1 and PAN-2 ACFs in the temperature range of 303K to 373K. Sharp decrease of adsorption was observed over both ACFs beyond 333K where PAN-ACF-1 and 2 adsorbed only 40 and 15 mgH_2O/g.

Figure 3 illustrates the adsorption of H_2O at 80% (rh) and its desorption under 1atm over granular activated carbon and ACFs at 303K. Rapid adsorption of ACF compared to that of the activated carbon is noted. Especially, saturation of adsorption was achieved within 10min over PAN-1-ACF. Other ACFs did within 30min, while granular activated carbon did not achieve before 60min.

The adsorbed H_2O was desorbed by the dry gas fixed 0% (rh) at 303K. Rapid desorption of Pitch-ACF was noted

Figure 4 illustrates the breakthrough profiles of H_2O over ACFs. PAN-1-ACF adsorbed H_2O of 80% (rh) almost completely for 50min and then exhibited a rapid breakthrough within 20min to 80% (rh). Pitch and PAN-2-ACF showed rather early breakthrough to 20% (rh) by 20 and 30min, respectively, very slow increase of humidity to 40% (rh) for following 50min and then rather rapid increase to 80% (rh) within 20min.

DISCUSSION

The present communication reported the unique adsorption and desorption features of H_2O over ACFs. The rapid adsorption and desorption range under different relative humidity in a narrow temperature are the characteristics. The adsorption capacity and achievable humidity at the adsorption are the other characteristics. The Pitch and PAN based ACFs exhibited some contrast behaviors. Such characteristics may originate from the surface chemistry and geometry of ACFs. The surface oxygen functional groups appear to govern the adsorption at lower humidity range (0 ~50% rh), while pores appear filled by condensed H_2O at 50~100% (rh) due to capillary condensation. Pore size and volume may govern the adsorption in this range. ACFs of rapid adsorption and desorption of H_2O may provide an energy saving humidity control device.

REFERENCES

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2. I. Mochida, S. Kawano, S. Kisamori, H. Fujitsu and T. Maeda, *Carbon Lett.* 32, 175 (1994).
3. Y. Sanada, M. Suzuki, K. Fujimoto, *Active carbon*, p. 190, Koudansha, Tokyo (1992).

Table 1 Some properties of as-received carbons.

Dose	Elemental analyses (%) C	H	N	O	Ash	BET surface area (m^2/g)
Pitch-ACF *	89.8	1.0	0.6	8.5	0.1	480
PAN-1-ACF**	77.5	1.8	9.7	11.0	0.1	450
PAN-2-ACF**	81.5	1.4	5.3	9.7	2.1	850

* activated carbon fiber from pitch
** activated carbon fiber from polyacrylonitrile

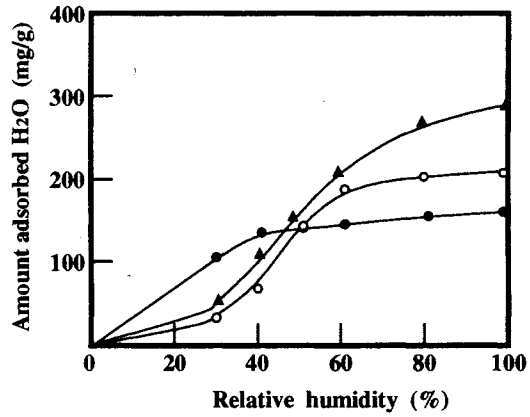

Figure 1 Adsorption isotherm of H_2O over ACFs at 303K.

○ Pitch-ACF ● PAN-1-ACF ▲ PAN-2-ACF

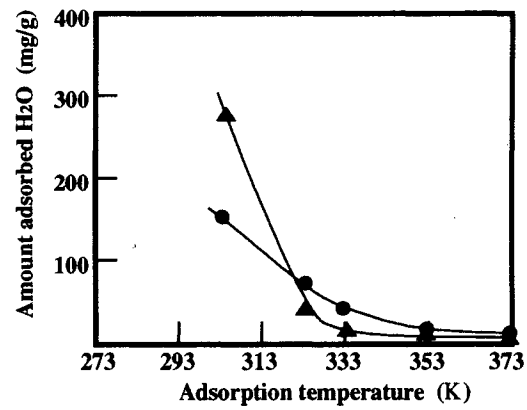

Figure 2 H_2O adsorption amount at various temperature.
H_2O pressure : 25 mmHg

● PAN-1-ACF ▲ PAN-2-ACF

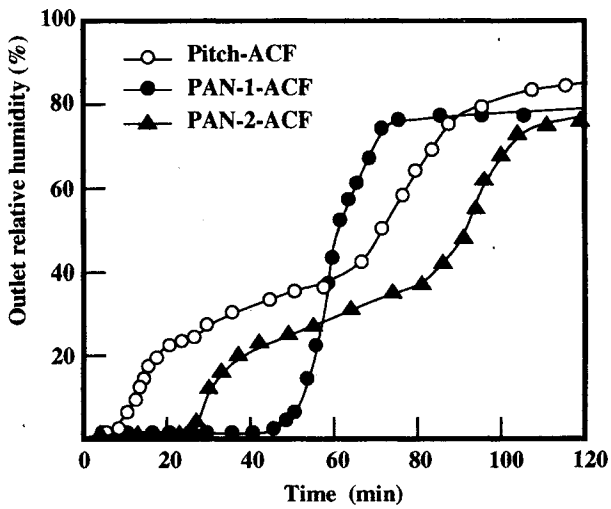

Figure 4 H_2O break through profiles over ACFs.

inlet relative humidity : 80%
sample amount : 2.0g
flow rate : 300ml/min ($W/F = 6.7 \times 10^{-3}$)
adsorption temperature : 303K

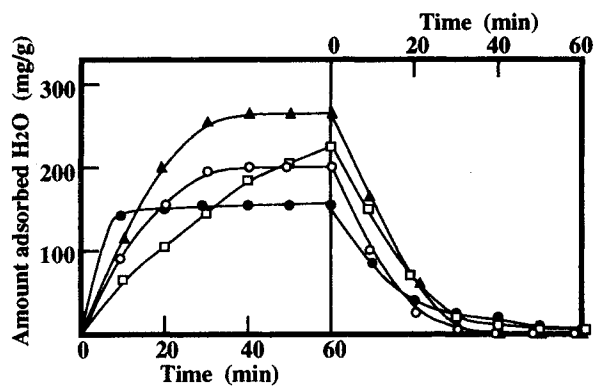

Figure 3 Adsorption and desorption of H_2O over ACFs at 303K.
adsorption condition : Rh. 80%
desorption condition : Rh. 0%

○ Pitch-ACF ● PAN-1-ACF ▲ PAN-2-ACF □ AC (coconut shell)