ADSORPTION OF ORGANICS PRESENT IN AIR ONTO ACTIVATED CARBON FIBERS

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Introduction

The removal of volatil organic compunds (VOC) with granular activated carbon (GAC) is commonly performed in the treatment of air. Activated carbon fibers (ACF) in the form of felt or cloth have received an increasing attention in recent years as an adsorbent for purifying air or water. Some studies on this new material were carried out mainly in gaseous phase and showed that ACF seemed very effective in removing contaminants from air [1]. Thwaites et al. [2] showed that initial adsorption rates are 2.5-10 times larger with fibers than with granules.

The main objective of the present study is to assess the removal of volatil organic compounds in single component air. Classical models were applied to determine adsorption parameters and to modelize the transfert in batch reactors and in dynamic filters.

Experimental

Characteristics of activated carbon cloth are presented in Table 1.

sample identifier	CS1501	RS1301
presentation	cloth	cloth
precursor	rayon	rayon
BET surface area ($m^2\ g^{-1}$)	1689	1460
micropore surface area (%)	87.5	77.2
micropore volume ($cm^3\ g^{-1}$)	0.665	0.506
micropore volume (%)	96.3	68.1
median pore diameter (Å)	6.9	7.3

Table 1. Characteristics of activated carbon cloth

A picture of mesoporous material RS 1301 is shown in Figure 1

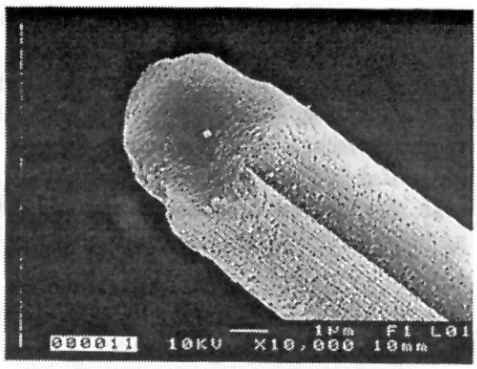

Figure 1 : One fiber of activated carbon cloth CS 1301

Batch reactor (2 L) continously stirred is used to determine the transfert rate and adsorption capacities of ACC against VOC.

Dynamic adsorption is performed on laboratory system with different solvents. The concentration is in a range of 60 mg/m^3 to 10 g/m^3. The air velocity is from 0.1 to 0.35 m/s.

Solvents are analysed using chromatography technics.

Results and Discussion

Adsorption in batch systems

A fast adsorption rate is found for the activated carbon cloth compared with granular activated carbon.

Classical isotherm relations were used :

- Freundlich equation

$$q_e = K \cdot C_e^{1/n}$$

- Langmuir's relation

$$q_e = \frac{b \cdot q_m \cdot C_e}{1 + b \cdot C_e}$$

where q_e is the adsorption capacity at the equilibrium ($mg\ g^{-1}$), C_e the solution concentration at the equilibrium ($mg\ L^{-1}$), K a Freundlich parameter ($mg^{1-1/n}\ L^{1/n}\ g^{-1}$), 1/n a Freundlich parameter, q_m the maximum

adsorption capacity (mg g^{-1}) and b the Langmuir equilibrium parameter (L mg^{-1}).

Data are presented in Tables 2 and 3. A great amount of vapour is adsorbed.

	K	1/n
RS 1301		
Acetone	388	0.35
Trichloroethylene	3.8	0.90
Perchloroethylene	70	0.06
CS 1501		
Perchloroethylene	0.015	1.79
Toluene	31	0,115

Tableau 2 : Freundlich equation parameters

ACC	RS 1301	CS 1501
Acetone	420	260
Trichlorethylene	660	550
Perchloroethylene	750	-

Tableau 3 : Adsorption capacity (mg/g)

Adsorption in dynamic systems

An example of VOC adsorption is given in Figure 2. Classical Breakthrough curve is obtained.

A mass transfert model was applied in order to simulate the breakthrough curve :

$$C = \frac{C_0}{\left(1 + Ae^{-rt}\right)^{1/n-1}}$$

With C_0 and C the inlet and outlet concentrations (g/m^3), t time (min) and A, r and n equation parameters. Some data are shown in Table 4

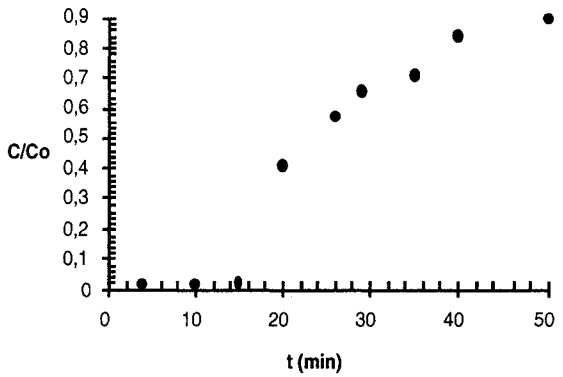

Figure 1 : Breakthrough curve. Solvent : perchloroethylene. 10 CS 1501 Layers, Air velocity 0,1 m/s, Co=10 g/m^3, Temperature 20°C

Conclusions

This study produces the following conclusions :

- ACF were shown to be good adorbents for volatil organic compounds present in air.
- Dynamic filters are useful in air purification.
- Classical model was used to modelize breakthrough curves.

Acknowledgments

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References

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2. Thwaites M.W., Stewart M.L., McNeese B.E., Sumner M.B. *Fuel Process. Tech.*, 1993, 34, 137-145.

Adsorbat	ACC	Operating conditions	A	r	1/n-1	t_b (min)	Capacity (%)
Acetone	RS 1301 10 Layers	C_0 = 10 g/m^3 U_0 : 0,1 m/s	0.135	0.28	85.1	5.72	21
Dichloromethane	RS 1301 10 Layers	C_0 = 10 g/m^3 U_0 : 0,1 m/s	480	0.59	4.95	11.2	32
Trichloroethylene	RS 1301 10 Layers	C_0 = 10 g/m^3 U_0 : 0,1 m/s	0.97	0.25	103.1	15	39
Perchloroethylene	CS 1501 10 Layers	C_0 = 10 g/m^3 U_0 : 0,1 m/s	0.94	0.10	99.2	13.5	47
Toluene	CS 1501 10 Layers	C_0 = 60 mg/m^3 U_0 : 0,35 m/s				12	15

Table 4 : Mass transfert model parameters (1 layer = 9.62 cm^2= 0.2 g ACC)