POSTER

EQUILIBRIA AND KINETICS OF HYDROCARBONS ADSORPTION FROM WATER SOLUTIONS BY ACTIVE CARBONS

N.A.Eltekova and Yu.A.Eltekov

Institute of Physical Chemistry
Russian Academy of Sciences
Moscow 117915

INTRODUCTION

As it is known,activated carbon is one of the many adsorbents for uptake of various organic impurities from waste water with the proper choice of the conditions for the correct operation of adsorbents. Activated carbons are characterized with well-developed system of micropores in which the molecules of organic compounds are adsorbing very strongly. For adsorption occuring on microporous solids the theory of volume filling of micropores (TVFM) has been generally accepted [1,2]. The general equation of this theory is the Dubinin-Radushkevich (DR) equation [1].The DR equation is successful in expressing vapor adsorption on the activated carbons with homogeneous microporous structure as it has been verified by great number of researches. There were many attempts to apply the DR - equation for the description of liquid-phase adsorption by activated microporous carbons.
The main purpose of this work was to test the TVFM equations applicability for benzene, toluene and p-xylene adsorption from water solutions on the commercial activated carbons.

EXPERIMENTAL

The structural characteristics of activated carbons used are summarized in Table 1. Before the adsorption measurements the carbons were washed consecutively with benzene, acetone and distilled water and then evacuated at 150°C for 6 h. Benzene,toluene and p-xylene of grade "For spectroscopy" provided by Khimreaktiv were used without further purification. As a solvent bidistilled water was used. The adsorption measurements were made at 25°C by conventional batch adsorption method described in details in [3,4]. The equilibrium concentration of hydrocarbon in water c was determined by an ultraviolet spectrophotometer SP 8000 (Pye Unicam, U.K.). Adsorption n_1^s of hydrocarbons was calculated as

$$n_1^s = (c_0 - c)\, V / m_a \qquad (1)$$

where c_0 is initial concentration of aromatic hydrocarbon in water solution, V is solution volume in an adsorption flask and m_a is an adsorbent amount in the experiment. For the description of hydrocarbon adsorption from water solutions we used the modified DR equation in following form [2]

$$n_1^s = w_{01} V^{-1} \exp[(A/bE_{01})^2] + w_{02} V^{-1} \exp[(A/bE_{02})^2] \qquad (2)$$

and in form known as DS (Dubinin - Stoeckli) equation [5]

$$n^s = w_0/2B\ V_1 \exp(mbA^2/B^2)[1+\mathrm{erf}(b/B\delta\sqrt{2})] \qquad (3)$$

where $A=RT\ln(c_0/c)$, $B=(1+2mb^2A^2)^{1/2}$, $m=(1/\beta k)^2$, volume V_1 is a molar volume of hydrocarbon, $w_0=w_{01}+w_{02}$ expresses the micro- and supermicropores volumes, b is half-breadth of slit micropores, β is affinity coefficient, δ is a standard deviation.

RESULTS AND DISCUSSION

The adsorption isotherms (Fig. 1 and 2) demonstrated also good accordance of DR and DS equations with experimental adsorption isotherms for both activated carbons in the range of $0.04 < x < 0.4$. The comparison DR and DS equations for $0.01 < x < 0.4$ showed that DR equation described the adsorption of aromatic hydrocarbons in water solutions on both activated carbons covering wide range of equilibrium concentrations. Therefore the activated carbons AG3 and BAC should relate to the adsorbents with heterogeneous microporous structure. The comparison of w_0 values calculeted by DR and DS equations (Table 2) suggests that the contribution of aromatic hydrocarbons adsorption on mesopore surface in total sorption process plays the crucial role. The kinetics coefficients were calculated from experimental data by using the modified Wicke equation. Equilibria constants and kinetics coefficients were used in mathematician model of adsorption process for water purification. The results obtained are important not only for the theory of physical adsorption but also for the industrial sorption processes of the separation, evolution and purification. Accurate isotherms expressions facilitate the use of measured adsorption equilibrium data in

dynamical fixed bed model while also allowing for an analysis of thermodynamical guanities important in extrapolating and evaluating data.

CONCLUSION

Ther DR and DS equations have been applied for the description of aromatic hydrocarbons from water solutions by commercial microporous carbons. The results obtained have shown that both carbons have the heterogeneous micropore structure.

REFERENCES

1. M.M. Dubinin and L.V. Radushkevich, Dokl. Akad.Nauk SSSR, 55 331 (1947).
2. M.M. Dubinin, Carbon, 23 373 (1985).
3. A.M.Stadnik and Yu.A.Eltekov, Zhurn. Fiz. Khim., 49. 771 (1975).
4. N.A.Eltekova and Yu.A.Eltekov, Fundamentals of Adsorption, Ed. M.Suzuki, Kodansha Tokyo, p.153 (1993).
5. M.M. Dubinin and H.F. Stoeckli, J. Coll. Ifnterface Sci., 75. 34 (1980).

Table 1 - Structural Characteristics of Carbons

Adsorbent	Granula size, mm	Total porosity, dm^3/kg	Micropore volume dm^3/kg	Mesopore volume dm^3/kg	Oxygen content wt,%
AG3	2.0 ∓0.5	0.90	0.26	0.09	0.5
BAC	1.5+0.5	1.72	0.23	0.09	6.0

Table 2 - Parameters Characterizing the Porous Structure of Carbons

Solute	Carbon	DR				DS				
		w_0 cm^3/g	b nm	E_0 kJ/mol	RSD %	w_0 cm^3/g	b nm	E_0 kJ/mol	o nm.	RSD %
Benzene	AG3	0.27	1.39	8.6	2.6	0.33	1.60	7.5	0.28	1.6
	BAC	0.26	1.24	9.6	2.0	0.29	1.35	8.9	0.19	7.7
Toluene	AG3	0.33	1.25	9.6	0.4	0.33	1.26	9.5	1.10	1.6
	BAC	0.26	1.07	11.2	0.8	0.26	1.08	11.1	0.09	3.8
p-Xylene	AG3	0.32	1.02	11.8	0.7	0.30	1.05	11.4	0.20	2.5

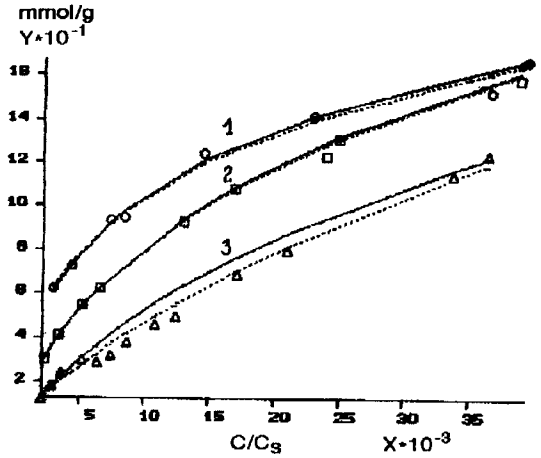

Figure 1 - Adsorption of p-xylene (1), toluene (2) and benzene (3) on AG3. Solid line - DR equation, broken line - DS equation, symbols - experimental points

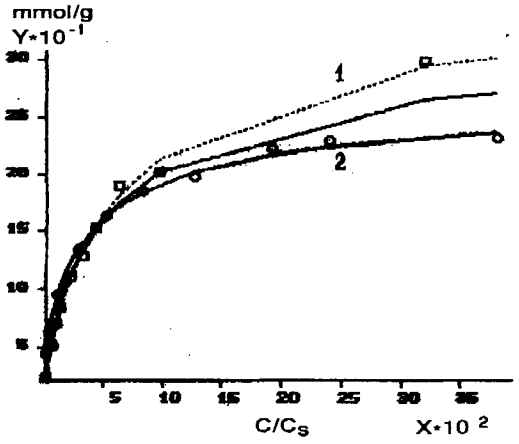

Figure 2 - Adsorption of toluene (1) and benzene (2) on BAC. Denotation as in Figure 1.