

THE ADSORPTION RESEARCHING OF POLYMERIC ADSORBENTS ON THE BASE OF GENERAL EQUATION OF POLYMERIC ADSORPTION

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Introduction

Porous polymeric sorbents are the new and effective class of porous sorbents. In recent years polymeric sorbents have been increasingly viewed as an alternative to activated carbon for the removal of specific organics from contaminated water. Early investigations researched that, on a mass basis, polymeric sorbents have a lower sorption capacity for most organics than activated carbon [1]. However, polymeric sorbents have been shown to selectively remove some organic compounds [2-3]. The wide variations in chemical compositions, surface area, porosity available for polymeric sorbents present the possibility of customising this kind of sorbents for the selective removal of specific organic solutes. The regeneration of polymeric sorbents can easily be accomplished with a solvent, while a high temperature and /or steam is needed for the regeneration of activated carbon [4].

The Langmuir, Polanyi, BET, Dubinin-Radushkevich equations are often used to describe adsorption phenomena with the porous polymeric adsorbents [1-3]. The significant problem is the simultaneous definition of all unknown adsorption parameters. We solved this problem by working out new approach on the base of the general equation of polymeric adsorption. Method for simultaneous definition of three unknown parameters of the equilibrium, particularly, of value of the monolayer adsorption, equation constant and index degree is worked out. The way of the definition is to minimize the functional of discrepancy between experimental dimensions and accounted numbers.

Experimental

In this study two types of the polymeric sorbent were investigated: Porolas T and polysorb G-60. The properties of these adsorbents were described in [5]. Prior to use, the sorbents were purified. Fine particles were removed by decanting in isopropyl alcohol and unreacted monomers by extraction in a Soxhlet apparatus for 8 h. Then the copolymer was washed in a column with the same solvent and water. The washing was checked spectrophotometrically.

The aqueous-phase sorption of phenol and its derivatives: m-aminophenol and m-nitrophenol, benzoic acid and its derivatives: m-oxybenzoic, aminobenzoic, 2,4-dihydroxybenzoic acids, m-nitrobenzoic, and others: p-chloroanilin, gallic acid, o-phthalic acid onto polymeric sorbents was obtained using the "bottle-point" method [3,5]. Initial and equilibrium sorbate concentrations were determined in a UV spectrophotometer in all cases. The amount sorbed was calculated from a mass balance on the solute in the aqueous phase.

Results and Discussion

A method for adsorption equilibrium parameters simultaneous calculation for individual substances have been proposed, which is based on the usage of modified polymolecular adsorption equation [6]. This equation must satisfy by two fundamental conditions: a) under little values of pressure p the isotherm could be transformed into Henri-isotherm b) if $p \rightarrow p_s$ (p_s is the pressure of saturated steam) the value of adsorption $a \rightarrow \infty$, but Gibb's integral must be ultimated.

The main formula for calculation, formulated for sorption from aqueous solution, can be defined

$$a = \frac{a_m K(C/C_s)}{1 + K(C/C_s)[1 - (C/C_s)]^n}, (1)$$

where: a - magnitude of the adsorption at the concentration C ; a_m - magnitude of the adsorption of the monolayer; K - constant in the equation of polymolecular adsorption; n - value of exponent; C - concentration of adsorbate in water; C_s - solubility of the adsorbed substance in water, found from literature.

It must be mentioned that, in a difference to [6], the value of n in the equation (1) could have all positive meaning.

For simultaneously determining of a_m , K and n we used the mathematical method of functional minimization [7]. Results for calculated adsorption parameters onto porous polymeric sorbents are reported in tables. The observed data

indicated that the values of n changes between all meaning in the region 0,1 - 0,9. The bigger values for phenol and m-aminophenol during the adsorption onto porolas T could be explained by considerable meaning of soluble of these substances. The values of a_m , calculated by two methods, have the nearest meaning.

Conclusions

Method for simultaneous definition of three unknown parameters of the equilibrium: monolayer volume, equation constant and index degree is worked out. The way of the definition is to minimize the functional of discrepancy between experimental dimensions and accounted numbers. Proposed method allows to calculate all three adsorption parameters with good approximation.

References

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Table 1. The values the parameters of adsorption process onto porolas T, calculated by means of proposed method (I) and according to [6] (II)

Adsorbate	I			II	
	a_m , mmol/g	K	n	a_m , mmol/g	K
Benzolic acid	2,08	5,80	0,31	1,84	6,87
m-oxybenzolic acid	0,94	14,60	0,49	0,90	22,60
o-aminobenzolic acid	1,37	15,95	0,09	1,22	20,40
m-nitrobenzolic acid	2,28	7,63	0,61	2,40	8,03
2,4-dihydroxybenzolic acid	1,27	12,10	0,12	0,96	22,50
o-phthalic acid	0,73	12,55	0,37	0,77	13,01
Gallic acid	0,36	7,12	0,23	0,40	8,33
p-chloroaniline	2,50	13,30	0,57	2,35	17,02
Phenol	1,45	176,0	4,35	1,90	131,60
m-aminophenol	1,50	60,20	14,60	1,75	15,90
m-nitrophenol	2,02	48,40	0,69	2,46	26,30

Table 2. The values the parameters of adsorption process onto polysorb G-60 calculated by means of proposed method (I) and according to [6] (II)

Adsorbate	I			II	
	a_m , mmol/g	K	n	a_m , mmol/g	K
Benzolic acid	0,50	4,69	0,20	0,40	6,25
o-aminobenzolic acid	0,74	9,17	0,20	0,62	11,52
Gallic acid	0,40	8,73	0,90	0,45	7,41
p-chloroaniline	0,96	12,09	0,87	0,87	15,87
m-aminophenol	1,20	10,28	0,23	0,84	17,10