ipt Instituto Politécnico de Tomar

MASTER in CHEMICAL TECHNOLOGY

SURFACE AND INTERFACE CHEMISTRY

Exercises – Adsorption of gases in solids

1. Data in the table refer to the adsorption of CO (carbon monoxide) in coal at 273 K. Confirm that they obey to the Langmuir isotherm and obtain the constant K and the volume corresponding to a monolayer.

P/torr	100	200	300	400	500	600	700
V/cm^3	10.2	18.6	25.5	31.5	36.9	41.6	46.1

2. The following data refer to the adsorption of nitrogen in a sample of 0.92 g of silica gel at 77 K, being p the equilibrium pressure and V the adsorbed volume:

P / kPa	3.7	8.5	15.2	23.6	31.5	38.2	46.1	54.8
V/cm^3(STP)	82	106	124	142	157	173	196	227

Saturated vapor pressure, P^s = 101.3 kPa

Represent the adsorption isotherm and use the BET equation to calculate the specific area of the sample of silica gel taking the molecular nitrogen area = 16.2×10^{-20} m^2.

3. The following results refer to the adsorption of nitrogen in a sample of graphitized carbon and give the ratio of nitrogen pressures at temperatures of 90 K and 77 K to get a certain amount of adsorption:

Quant. of N_2 adsorbed (V/V_m)	0.4	0.8	1.2
P(90 K) / P (77 K)	14.3	17.4	7.8

Calculate the isosteric heat of adsorption for each value of V/V_m and comment.

4. The decomposition of phosphine, PH_3, in tungsten, is first order at low pressures and zero-order the high pressures. Explain (hint: use the Langmuir isotherm).

5. The following data refer to the adsorption of n-butane at 273 K for a sample of tungsten powder that has a specific area (determined by nitrogen adsorption measurements at 77 K) of 6.5 $m^2.g^{-1}$.

Relative Pressure, P/P^s	0.04	0.10	0.16	0.25	0.30	0.37
V_{gas} adsorbed, cm^3(STP).g^{-1}	0.33	0.46	0.54	0.64	0.70	0.77

Use the BET equation to calculate the area of molecular butane adsorbed in the monolayer and compare with the value of 32.1×10^{-20} m^2/molecule estimated from the density of the liquid butane.

6. For the project of an installation for the fluorination of butadiene, it was studied the adsorption of butadiene in a catalyst at 15° C. The results were:

P / torr	100	200	300	400	500	600
V / cm^3	17.9	33.0	47.0	60.8	75.3	91.3

Verify if the Langmuir isotherm is suitable to these pressures. Apply also the BET isotherm. Comment. P^s (butadiene) = 200 kPa

7. Use the Kelvin equation to calculate the radius of pores that correspond to the capillary condensation of nitrogen at 77 K and a relative pressure of 0.5. Consider

the adsorption in multilayer's as having the thickness of 0.65 nm at this pressure. For the nitrogen at 77 K, γ = 8.05 mN.m-1 and the molar volume is 34.7 $cm^3.mol^{-1}$.

8. The adsorption of benzene in graphite follows a Langmuir isotherm. T the pressure of 1 torr the volume of benzene adsorbed on a sample of 2 mg of graphite is 4.2 mm^3 at STP. At the pressure of 3 torr is 8.5 mm^3. Admitting that the benzene molecule occupies 30 A^2, estimate the surface area of graphite.