**Assignment 1-Adsorption**

**Ques 1.** (fitting the adsorption equilibrium data using freundlich isotherm) Fit the given data to freundlich isotherm and determine the adsorption parameters for the two amino acids. Comments on the goodness of fit by calculating the correction coefficients.

|  |  |  |  |
| --- | --- | --- | --- |
| Glycine | | Phenylalanine | |
| Soln. conc. | Amt. adsorbed | Soln. conc. | Amt. adsorbed |
| (mol/L) | (mol/g solid) | (mol/L) | (mol/g solid) |
| 0.0126 | 7.94\*10-6 | 0.0112 | 6\*10-5 |
| 0.0251 | 1.14\*10-5 | 0.0224 | 1.2\*10-4 |
| 0.10 | 5.62\*10-5 | 0.0302 | 1.58\*10-4 |
| 0.1995 | 1.12\*10-4 | 0.0355 | 1.78\*10-4 |

**Ques 2.** Equilibrium adsorption data for benzene vapour on silica gel at different temperature are given below. (a) fit the data to Langmuir, Freundlich isotherms and obtain the isotherm equation, which isother gives a better fit. (b) Draw the adsorption isosteres and calculate the heat of adsorption (prepare in pvs 1/T plots for q=0.15 and q=0.25 mmol/g adsorbent) .

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| P\*103 atm | Q\*102 mmol benzene adsorbed per g gel | | | |
|  | 70 ℃ | 90℃ | 110℃ | 130℃ |
| 0.5 | 14 | 6.7 | 2.6 | 1.13 |
| 1 | 22 | 11.2 | 4.5 | 2 |
| 2 | 34 | 18 | 7.8 | 3.9 |
| 5 | 68 | 33 | 17 | 8.6 |
| 10 | 88 | 51 | 27 | 16 |
| 20 | - | 78 | 42 | 26 |

**Ques 3.** Data for equilibrium adsorption of ethane and propane on MSC 5A carbon molecules sieve at 30℃ are given below fit the data for the individual gases to langmuir’s isotherm. Calculate the amount of ethane and propane adsorbed per kg adsorbent., when in the equilibrium with an equimolar mixture of ethane and propane at a total pressure of 100000 pascal.

|  |  |  |  |
| --- | --- | --- | --- |
| ethane | | Propane | |
| P(kPa) | Q (mmol/g) | P(kPa) | Q (mmol/g) |
| 3.067 | 0.858 | 0.227 | 0.565 |
| 5.733 | 1.081 | 0.893 | 0.955 |
| 9.733 | 1.310 | 1.653 | 1.238 |
| 15.13 | 1.493 | 4 | 1.463 |
| 21.47 | 1.649 | 8 | 1.612 |
| 27.87 | 1.746 | 13.6 | 1.723 |
| 36.13 | 1.862 | 24 | 1.803 |
| 45.13 | 1.939 | 39.47 | 1.859 |
| 58.53 | 2.025 | 57.67 | 1.9 |
| 83 | 2.128 | 84 | 1.955 |

**Ques 4.** The following data on equilibrium adsorption of benzene on silica gel at 303 K are given below. Estimate the surface area of the adsorbent if on more than mono molecular surface coverage occurs at high pressure. (ρL=0.875 g/cm3).

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| P(kPa) | 1.193 | 2.373 | 4.733 | 7.36 | 8.81 | 13.43 |
| Q (mmol/g) | 2.294 | 3.043 | 3.608 | 3.757 | 3.794 | 3.872 |

**Ques 5.** A stream of N2 containing 0.1% benzene flow through a packed bed of GAC of particle size 3 mm in dia; temperature 25℃; pressure 1 atm; superficial gas velocity 0.28 m/s; diffusivity of benzene in N2 0.102 cm2/s at 311.3 K; viscosity of gas 1.85\*10-5 kg/(m.s); average pore dia 15 nm; bed porosity 0.43; particle porosity 0.45 pore tortuosity 2.8. Estimate the external mass transfer coefficient and effective pore diffusivity.

**Ques 6.** Breakthrough data of acetone in air flowing through a bed of adsorbent are given below and the experimental parameters are superficial gas velocity 0.25 m/s; Co 0.13 gmol/m3; bed hight 50 cm. calculate Breakthrough time if the breakthrough concentration is taken as 2.5% of the feed concentration, and velocity of the stoichiometric front.

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Time, min | 180 | 187.5 | 191 | 195 | 205 | 210 | 215 | 220 | 225 |
| C/Co | 0 | 0 | 0.005 | 0.018 | 0.91 | 0.143 | 0.210 | 0.285 | 0.372 |
| Tim,e min | 230 | 235 | 240 | 245 | 250 | 255 | 260 | 265 | 270 |
| C/Co | 0.46 | 0.553 | 0.655 | 0.743 | 0.825 | 0.892 | 0.948 | 0.98 | 0.992 |

**Ques 7.** A dilute vent stream with 2 vol% of a toxic vapour passes through a packed adsorption column at 299 K and 1.2 bar pressure. The adsorption equilibrium follows the Langmuir model and the parameters are qm 6.2 gmol/kg and K 0.12 m3/gmol. The volumetric mass transfer coefficient is estimated to be kma 35s-1. Adsorbent bulk density 700kg/m3; ɛb 0.38; and superficial gas velocity 0.32m/s; and c/Co 0.025. Calculate the velocity of the MTZ if the wave front maintains a constant pattern, also calculate the breakthrough conc time if bed height is 2m.

**Ques 8.** A solution of sodium acetate (110 g/L) has 0.2% Ca2+ in it. It is suggested to removed 90% of the Ca2+ ions by a cation exchange resin in the sodium form having an exchange capacity of 2 eq./L. calculate the amount of resin required to treat 1 m# of the feed solution. Does the resin appear to be commercially attractive.

**Ques 9.** Agriculture waste have proven potential of adsorption of organic contaminants and even metal ions form effluents. An attempt to estimate the effectiveness of gram husk to remove textile dues from simulated waste water has been reported. In a particular experiment, 0.9g of washed and dries husk was contacted with 100 mL of methylene blue solution in a shaker bath at 303 K . the sample withdrawn from time to time analyzed as follows. Calculate rate parameter k2 and correlation coefficient.

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Time, min | 0 | 5 | 10 | 15 | 20 | 25 | 30 | 40 | 50 |
| Dye (mg/l) | 488 | 328 | 247 | 175 | 127 | 100 | 79 | 52 | 40 |