Total No. of Questions : 12]

SEAT No. :

P865

[Total No. of Pages : 4

[4659] - 250

B.E. (Petrochemical Engineering)

b - NOVEL SEPARATION PROCESSES

(Elective - I) (2008 Pattern) (Semester - I)

Time : 3 Hours] *[Max. Marks : 100*

Instructions to the candidates:

1) ***Answer Any Three questions from each section.***
2) ***Answers to theTwo Sections should be written in separate answer books.***
3) ***Neat diagrams must be drawn and well commented.***
4) ***Use of logarithmic tables, slide rule, Mollier charts, electronic pocket Calculator and steam tables, is allowed.***
5) ***Figures to the right indicate full marks.***
6) ***Assume suitable data, if necessary.***

SECTION - I

Q1) a) Draw concentration profiles for membrane processes for following cases: **[6]**

i) two liquid films and a solid and,

ii) two gas films and a solid.

b) Classify separation processes by giving suitable example(s). Discuss the selection criteria for the same with suitable examples. **[8]**

c) In batch evaporation, heat is added to a solution of solutes to remove a solvent (usually Water) and concentrate the remaining solutes. After sufficient time, the concentrated solution is sent to the next unit. Would you term this process rate-based and equilibrium based? (i.e. which is the best Choice?) Explain in brief. **[4]**

OR

Q2) Classify the models for gas separation by membranes. Develop a complete mixing process model for membrane separation processes, mentioning important assumptions. Discuss different design cases with solution strategies in this model. **[18]**

Q3) An 10-micron tubular membrane is used to recover salt A from a dilute solution. The solutions to either side are at 0.025 and 0.0045 kmol/m^3, with mass transfer coefficients of 3.5×10^{-5} and 2.25×10^{-5} m/s respectively. The distribution coefficient is 0.79 and the diffusivity of A in the membrane is 2.8×10^{-11} m^2/s. **[16]**

P.T.O.

a) Calculate the percentage of total resistance to mass transfer contributed by the membrane.
b) Calculate the membrane area needed to allow recovery at 0.017 kmol/hr.
c) Flow inside the tube is turbulent and mass transfer follows the Gilliland, Sherwood & Linton correlation. If the velocities of both solutions are doubled, what will the membrane resistance now be?

OR

Q4) a) Discuss various membrane modules with neat sketches for membrane separation processes by giving merits and demerits of each of them. **[10]**

b) Explain equilibrium based and Rate based separation processes with suitable examples. **[6]**

Q5) a) A membrane is to be used to separate a gaseous mixture of P and Q in one of the petrochemical complex. Assuming complete mixing model, calculate the following: **[12]**

i) the permeate composition
ii) the fraction permeated
iii) membrane area

Data::

Feed flow rate	$= 3.5 \times 10^5$ cm^3 (STP)/s
Feed composition of A	= 0.55 mole fraction
Desired composition of reject	= 0.25 mole fraction
Thickness of membrane	$= 2.45 \times 10^{-3}$ cm
Pressure on feed side	= 100 cm Hg
Pressure on permeate Side	= 50 cm Hg
Permeability of A, P_A	$= 25 \times 10^{-10}$ cm^3 (STP) cm/(s.cm^2.cm. Hg)
Permeability of B,P_B	$= 10 \times 10^{-10}$ cm^3 (STP) cm/(s.cm^2.cm. Hg)

b) Write a brief note on: "Hydrotopes". **[4]**

OR

Q6) a) Draw neat sketches for: **[8]**

i) Separation by phase creation.
ii) Separation by phase addition.
iii) Separation by barrier.
iv) Separation by force field or gradient.

b) A heart-lung machine uses a 0.175mm silicone rubber membrane with a permeability of 6.40×10^{-7} cm^3 O_2 (STP) mm/s.cm^2 cm Hg. The machine is to supply 355 cm^3/min of oxygen to a patient, where the partial pressure of oxygen in the blood is the equivalent of 30 mmHg. The machine is supplied with pure oxygen at 700mmHg, so gas film resistance can be neglected. If the resistance on the blood side were neglected also, how large would the membrane need to be? **[8]**

SECTION - II

Q7) a) Discuss in brief the process principles involved in Pressure Swing Adsorption (PSA) and Temperature Swing Adsorption (TSA) with industrial applications. **[12]**

b) Explain different types of adsorbents with their properties used in industrial operations. **[6]**

OR

Q8) The data on adsorption of ethane as Linde molecular sieve 5A^0, at 35°C is given in following table: **[18]**

P, [mm Hg)	U take, V [cm^3 (STP/gm]
0.17	0.059
0.95	0.318
5.57	1.638
12.09	3.613
111.32	24.236
220.87	34.278
300.05	38.340
401.25	41.779
500.18	44.037
602.74	45.693

a) Using the data given above determine if the Langmuir equation can be used to model the data.

b) Calculate the total surface area of solid, if density of ethane = 0.3555gm/cc.

Q9) Nitrogen gas contaminated with water at 920 mg per kg of N_2 is continuously fed to a pilot-scale adsorption column that contains a 0.268 m high bed packed with molecular sieve. Outlet data were as follows: **[16]**

Time (hours)	0	9	9.2	9.5	10.0	10.5	10.8	11.25	11.5	12.0	12.5	12.8
Water conc. (mg/kgN_2)	0	0.8	2.8	25	95	240	425	635	720	850	910	920

If break-through is defined here as being when c/c0 reaches 0.02, find the following:

a) Breakthrough time.

b) Height of "zone" of unspent (but not unused) bed in column.

c) Fraction of total sieve capacity used by breakthrough time.

d) Breakthrough time if an industrial column were to be built of the same cross-section, but with a bed height of 0.6m.

OR

Q10) a) Write down Van Deemter equation for Chromatography. Explain the meaning of each parameters involved in this equation. Derive an expression for optimum value of the mobile phase velocity and the plate height in terms of these parameters. **[8]**

b) Define the following terms in connection with chromatographic separations and give appropriate equations (Any Four): **[8]**

i) Partition coefficient (K).

ii) Retention Volume (V_R)

iii) Retention Ratio (R)

iv) Capacity factor (k')

v) HETP

vi) Resolution (Rs)

Q11) a) Two amino acids, glycine and alanine, were separated by liquid chromatography with the following results: **[12]**

Amino Acid	T_R, (minutes)	W (minutes)
Glycine	4.5	0.55
Alanine	5.2	0.65

i) Calculate the resolution of amino acids.

ii) Calculate the plate number for alanine.

iii) What is the minimum plate numbers needed to provide a resolution of 1.5?

iv) How do you get this high plate number?

b) Write a brief note on : Super Critical Fluid Extraction". **[4]**

OR

Q12) Write notes on: **[16]**

a) Reactive Separations.

b) Parametric Pumping.

c) Isoelectric Focusing.

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