**Q. Code: 472605**

B.E/B.TECH. Degree Examination, December 2020

Fifth Semester

**BT18502 Mass Transfer Operations**

(Regulation 2018)

Time: Three hours Maximum : 80 Marks

Answer **ALL** questions

**PART A - (8 X 2 = 16 marks)**

1. A mixture of acetone and chloroform separated using fractional distillation, in this processes, as we go higher in the fractionating column

   a) more risk of sublimation

   b) maximum stripping takes place

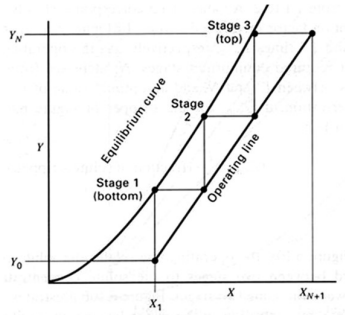
   c) temperature becomes lower

   d) minimum adsorption takes place

2. Two solvents A and B were mixed to form a binary mixture, if the solvents were mixed at azeotropic composition, then the relative volatility of the mixture will be

   a) 0 b) 1 c) >1 d) ∞

3. The equlibrium curve shown here indicates McCabe-Thiele plot for which of the following mass transfer operation




   1. Absorption
   2. Stripping
   3. Adsorption
   4. Extraction

   a) 1 and 2 b) 2 and 3

   c) 1 only d) 4 only e) 1, 2 and 4

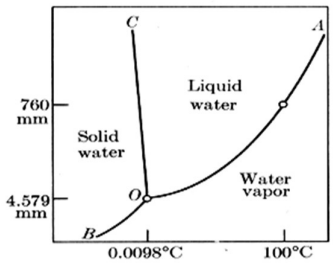
4. The curve of pressure vs temperature shown here is obtained for preservation of a bacterial culture by removal of moisture content, which of the following could be appropriate operating condition

   a) 770 mm Hg and 101 C

   b) 4 mm Hg and -0.0101 C

   c) 5 mm Hg and 10 C

   d) 5 mm Hg and 0.0101 C




5. In a mass transfer of solute across the thin film, how do you relate diffusivity and mass transfer coefficient?

6. If you are working to design an absorption column to handle high viscous fluid, how you will avoid flooding and channeling?

7. How thermal conditions of the feed is helps in deciding the feed position in the distillation column?

8. Justify addition of extractant to the solvent improves the selectivity factor in extraction processes.

**PART B - (4 X16 = 64 marks)**

9. (a) In a system with total pressure of 1 x $10^5$ N/m$^2$, and the temperature maintained at 0 $^oC$ a gas molecule A is diffusing through non diffusing mixture of B and C (with 2:1 ratio) under steady-state conditions. The diffusion path is 2.0 mm. The partial pressures of A at the 2 ends are 0.13 and 0.065 N/cm$^2$ respectively. Diffusivity $D_{AB}$ is 1.86 x $10^{-5}$ m$^2$/s and $D_{AC}$ is 6.99 x $10^{-5}$ m$^2$/s and R = 8314 (m$^3$.Pa)/(kg-mole.K). Calculate the molar flux of A in the mixture. **(16)**

**(OR)**

(b) In a rectifying sill column, mixture of A and B containing 70 mol% A was feed at one end and reflux product containing 41 mol% B was withdrawn from other end. The temperature was maintained at 365 K. If the resistance to diffusion is due to a vapour layer of 0.2 mm thickness, calculate the rate of interchange of A and B between the vapour and the liquid. The vapour pressure of B at 365 K is 54 kN m$^{-2}$ and diffusivity of vapours is 0.05 cm$^2$s$^{-1}$. The molar latent heats of vapourisation can be taken to be almost equal and pressure was maintained constant at 1 atm. **(16)**

10. (a) A feed mixture (acetone and methanol) containing 24 mole % methanol was feed into a continuous distillation column. If mixture was feed at its boiling point and reflux ratio was maintained at twice the minimum to be used, the distillate containing 77 mole % acetone and bottom product with 5 mole % acetone was obtained. **(16)**

Following is the equilibrium data:

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| x | 0 | 0.05 | 0.1 | 0.2 | 0.3 | 0.4 | 0.5 | 0.6 | 0.7 | 0.8 | 0.9 | 1.0 |
| y | 0 | 0.10 | 0.19 | 0.32 | 0.428 | 0.513 | 0.59 | 0.66 | 0.73 | 0.82 | 0.9 | 1.0 |

Determine the number of plates required for separation if the overall plate efficiency is 60%.

**(OR)**

(b) A feed containing 45 mole % A was feed into a plate type distillation column, the feed mixture is 50% vapour and 50% saturated liquid. It was desired to obtain top product with 96 mole % A and bottom product containing 5 mole % of A. **(16)**

Following is the equilibrium data:

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| x | 0 | 0.1 | 0.2 | 0.3 | 0.4 | 0.5 | 0.6 | 0.7 | 0.8 | 0.9 | 1.0 |
| y | 0 | 0.21 | 0.3 | 0.52 | 0.62 | 0.72 | 0.78 | 0.86 | 0.91 | 0.95 | 1.0 |

Determine the number of plates required for separation if the overall plate efficiency is 60%.

Determine the minimum reflux ratio and number of theoretical plates required if the reflux ration was maintained twice the minimum reflux.

11. (a) A plant metabolite having distribution coefficient of 5 between water and chloroform. If 50 ml of plant extract sample containing 0.050 M aqueous solution of metabolite using 15 mL of chloroform. Calculate extraction efficiency for single extraction and for three identical extractions. Also calculate number of extractions required to extract 99.9% of the metabolite. **(16)**

**(OR)**

(b) Pure solvent isopropyl ether is being used to extract an aqueous solution containing 25% acetic acid (by weight), aqueous solution of acetic acid was feed continuously at 1000 kg/hr and extracted in counter fashion with isopropyl ether to remove 95% of the acetic acid. Assume isopropyl ether and water are immiscible with each other. **(16)**

Use following equilibrium data:

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| x | 0 | 3 | 7 | 15 | 25 | 36 | 40 |
| y | 0 | 3.5 | 10 | 20 | 34 | 41 | 43 |

Calculate the minimum solvent required for every hour of operation.

12. (a) (i) Discuss about the isotherm model in which the adsorption is limited to single molecular layer. **(8 )**

(ii) If you are designing a model for adsorption kinetics, your process largely depends on surface area and pore size distribution, explain an adsorption kinetic models which suits best for your process. **(8)**

**(OR)**

(b) (i) Discuss about dryers used for large scale unit operations. **(8 )**

(ii) Assume you are working with a thermally unstable microbial product, you have to design an equipment for complete removal of moisture from the product. Discuss about equipment design and mass transfer principle behind the working of your designed equipment. **(8)**