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

Fifth Semester

BT16503 – Mass Transfer Operation

(Regulation 2016)

Time: Three hours Maximum : 80 Marks

Answer **ALL** questions

PART A - (8 X 2 = 16 marks)

1. A gas feed mixture containing 5 mol % of acetone and rest air entering the system, calculate average molecular weight of gas feed

   a) 34.05 b) 30.45 c) 28.4 d) 24.8

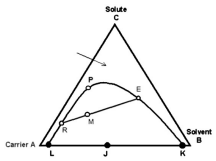
2. A counter-current absorbent reactor packed with 50 m height has 8 transfer units, calculate height of individual transfer unit

   a) 6.25 m b) 0.16 m c) 400 m d) 40 m

3. For saturated vapour feed the q line should be at _____ degree angle to the diagonal line of the vapour-liquid equilibrium plot

   a) 90 b) 45 c) 0 d) could not define based on feed

4. In the phase diagram given bellow, A, B and C denotes three different solvents. If A & B are partially miscible, then the region indicated with arrow denotes



   a) Homogeneous single phase

   b) Phase rich in A

   c) Phase rich in B

   d) Mixture of A and C

5. How diffusion principle is used in designing/choosing a material for contact lens?

6. If the operating line of rectification section and stripping section meets the equilibrium line (x-y) in distillation, discuss about reflux for this condition.

7. If no of theoretical stage required for distillation is found to be 21 and tray efficiency is 0.5. Calculate actual number of trays required for effective distillation.

8. How addition of extractant influences the extraction processes? If extractant concentration is increased in extraction processes, what will be the trend of solute concentration in raffinate?

PART B - (4 X16 = 64 marks)

09. (a) Calculate the molar flux of component A diffusing into the non-diffusing gas mixture containing B and C at the ratio of 2:1. If total pressure of the system is 100 kN/m^2 and temperature is maintained at 300 K. The partial pressures of A at the 2 ends are 15 and 7 kN/m^2 respectively. For the diffusion path of (your roll number) mm, the diffusivity D_{AB} is 2.5 x 10^{-5} m^2/s and D_{AC} is 7.5 x 10^{-5} m^2/s and R = 8314 (m^3.Pa)/(kg-mole.K). **(16)**

(OR)

(b) Calculate the molecular diffusion/ rate of transfer of benzene and toluene between the vapour and the liquid. In a simple rectifying column fitted with reflux at top to return some product, mixture of benzene and toluene as vapour was supplied at bottom. The column is insulated and heat losses can be neglected, At one point in the column, the vapour contains 0.3 mol fraction of toluene and the adjacent liquid reflux contains 0.59 mol fraction of benzene. The temperature at this point is 350 K. Assuming that the resistance to diffusion is due to a vapour layer of 4 mm thickness. The molar latent heats of vapourisation can be taken to be almost equal. The vapour pressure of toluene at 365 K is 54 kN m^{-2} and diffusivity of vapours is 0.05 m^2s^{-1}, processes operated at constant 1 atm pressure. **(16)**

10. (a) A gas from a petroleum distillation column has its concentration of H_2S reduced from 0.03 kgmole H_2S / kgmoles inert gas to 5 % of its value by scrubbing with a tri ethanol amine with water as a solvent in a counter current tower of height 40 m operating at 303 K and 1 atm. The equilibrium relation is Y= 2 X. Pure solvent enters the tower and leaves containing 0.013 kg mole H_2 S / kgmole of solvent. If the flow of inert hydrocarbon gas is 0.015 kgmole/ m^2S and the gas phase controls the mass transfer. Calculate the overall coefficient for absorption. **(16)**

(OR)

(b) Gas mixture is feed at 15 mol/s into a absorption tower, inlet gas contains 2 % by volume solute A, and 95 % of the original solute is removed by absorbing it in a solvent B. Solvent containing 0.4 mole fraction of solute enters the tower at the top and the exit liquid streams from the absorption tower contains 0.15 mole A per mole B. Find out the flow rate of the solvent entering the absorption tower on solute-free basis. **(16)**

11. (a) A fractional column separates a liquid mixture containing two components **A** (with molecular weight of 119.6) and **B** (with molecular weight of 76). The feed containing 50 weight % A is entering at it boiling point. The overhead product contains 6 % A and bottom component contains 95% A. If reflux ratio of twice the minimum reflux ratio is maintained, determine number of theoretical plates required. Also calculate actual number of trays required if tray efficiency is 0.8. **(16)**

Use following equilibrium data (x and y are mole fraction of **B** in liquid and vapor phase)

x	0.03	0.06	0.11	0.14	0.26	0.39	0.53	0.66	0.76	0.86	1.0
y	0.08	0.16	0.27	0.33	0.50	0.63	0.71	0.83	0.88	0.93	1.0

(OR)

(b) A methanol-water solution containing 36 mole % of methanol at 26.7 ºC is continuously distilled to yield a distillate containing 91.5 mole % methanol and residue containing 99 mole % water. The feed enters at its bubble point, if reflux is maintained at 3, determine number of theoretical plates using Ponchon-Savarit method. **(16)**

x or y mole fraction of methanol	Enthalpies of saturated liquid (KJ/kmol)	Enthalpies of saturated vapour (KJ/kmol)
0	8000	48000
1	7500	39000

Use following equilibrium data (x and y are mole fraction of methanol in liquid and vapor phase)

x %	4	10	20	30	50	70	90	95
y %	23	42	58	66	78	87	96	98.15

12. (a) Assume you are designing a model for adsorption kinetics, your process largely depends on porosity of the adsorbent, their distribution and available adsorption surface, which adsorption isotherm models which suits best for your process, explain why it suits best for your process, explain the chosen isotherm principles. **(16)**

(OR)

(b) If you are working with a thermally unstable microbial product, you are given a task 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. **(16)**