

Reg. No.

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B.E / B.TECH. DEGREE EXAMINATION, MAY 2023

Fifth Semester

BT18502 – MASS TRANSFER OPERATIONS*(Biotechnology)***(Regulation 2018)****TIME: 3 HOURS****MAX. MARKS: 100**

- CO 1** Choose suitable mass transfer operation for separation of compounds/solute.
CO 2 Demonstrate about gas -liquid, vapour- liquid and solid- liquid and liquid–liquid equilibrium.
CO 3 Solve problems on VLE and problems related to design calculation of distillation column.
CO 4 Develop the skill in the design mass transfer equipment's in process industries.
CO 5 Examine two-phase mass transfer processes and apply them for separation of components.

PART- A (10 x 2 = 20 Marks)

(Answer all Questions)

| | CO | RBT LEVEL |
|---|----|--------------|
| 1. How diffusion principle is used in designing/choosing a material for contact lens? | 1 | 3 |
| 2. Which mass transfer process is involved for gas exchange in the lungs? How the process varies with surface area? | 1 | 2 |
| 3. Describe flooding conditions in packed towers used for absorption and discuss how it affects packing materials. | 2 | 3 |
| 4. Compare tray type and packed absorption column based on the operation mode and absorption efficiency. | 2 | 3 |
| 5. 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. | 3 | 3 |
| 6. How q-line in distillation process influences the feed point in the column. | 3 | 3 |
| 7. Justify counter-current extraction process is better for the large scale operation of the feed containing a very high concentration of solute to be extracted. | 4 | 4 |
| 8. If extractant concentration is increased in extraction processes, what will be the trend of solute concentration in raffinate? | 4 | 4 |
| 9. How does critical moisture content influence the rate of drying? | 5 | 2 |
| 10. Differentiate chemisorption from physical adsorption. | 5 | 2 |

PART- B (5 x 14 = 70 Marks)

| | Marks | CO | RBT LEVEL |
|--|-------|----|--------------|
| 11.(a) (i) Derive an expression for steady state diffusion in gases with two components (A & B) with the condition $N_A = N_B$. Where N_A and N_B molar flux A and B. | (10) | 1 | 2 |
| (ii) Differentiate eddy diffusion and molecular diffusion. | (4) | 1 | 2 |
| (OR) | | | |
| (b) Explain briefly the Analogies and their usefulness in mass transfer studies. | (14) | 1 | 2 |
| 12.(a) A gas from a petroleum distillation column has its concentration of H_2S reduced from 0.03 kg mole H_2S / kg moles 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 20 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. | (14) | 2 | 3 |
| (OR) | | | |
| (b) An air-benzene mixture was entering the absorption tower at the rate of 389 kmol/h. Inlet gas containing 7 mol % benzene was entering the system. 82 % benzene was recovered using pure solvent (mol wt. 24) entering at 490 kmol/h. Calculate composition (weight %) of benzene in the exit gas and liquid outlet. Mol wt Benzene-78.11. | (14) | 2 | 3 |
| 13.(a) A mixture of benzene and toluene containing 60 mole % benzene is to be separated by distillation to give a product of 95 mole % benzene and a bottom product containing 10 mole % benzene. The feed enters a column at its bubble point. It is proposed to operate the column with reflux ratio of 2.5. Determine the number of theoretical plates needed and also find the position of feed plate for the following equilibrium data: | (14) | 3 | 3 |

| | | | | | | | | | | | | |
|---|---|------|------|------|-----|-----|-----|------|------|-----|------|-----|
| 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 | 0.12 | 0.21 | 0.38 | 0.5 | 0.6 | 0.7 | 0.75 | 0.85 | 0.9 | 0.95 | 1.0 |

(OR)

(b) Discuss about minimum reflux ratio in distillation, how purity of a low boiling (having low boiling point) product is improved in the bottom component. Explain about the significance of tray efficiency in distillation processes. (14) 3 3

14.(a) How do you choose an extraction equipment based for a large scale operation to extract a metabolite with high purity? Discuss with the help of neat flow chart. (14) 4 4

(OR)

(b) Assume you are working in R & D team to develop a counter current extraction process for extraction of polar plant metabolite. Design a process for extraction of polar metabolite and discuss equipment's required for the same. (14) 4 4

15.(a) Assume you are designing a model for adsorption kinetics, explain a simple kinetic model for designing adsorption using strong adsorbent. (14) 5 3

(OR)

(b) Sketch the drying curve and explain briefly about each steps. Explain the process of freeze drying. (14) 5 3

PART- C (1 x 10 = 10 Marks)

(Q.No.16 is compulsory)

| | Marks | CO | RBT LEVEL |
|--|-------|----|--------------|
| 16. 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. | (10) | 5 | 5 |
