Ex/FTBE/PC/B/T/324/2022

B. E. Food Technology and Biochemical Engineering Examination, 2022

(3rd Year, 2nd Semester)

Mass Transfer Operations II

Time : Three hours | Full Marks : 100

(50 Marks for each Part)

Use separete Answer Script for each Part

PART I (50 Marks)

Use of Psychrometric Chart is allowed.

Answer question no. 5 and any three from the rest.

1. From Ideal Gas Equation deduce an expression for absolute humidity of an air-water vapour mixture. How are humid volume and total enthalpy of air-water vapour mixture calculated? 5+10
2. Derive an expression for the wet bulb temperature line on a Psychrometric Chart. What is the significance of Lewis number? 13+2
3. An air-water vapour mixture has a dry bulb temperature of 60°C and a humidity of 0.033 kgwater/ kg dry air. Using the Psychrometric Chart and the relevant equations, calculate the relative humidity, dew point, wet bulb temperature, humid heat and humid volume. 15
4. What is meant by the water activity of a food substance? With a diagram show how deteriorative actions on food varies with its water activity. 3+12
5. Answer any one. (5)
   - (i) Empirical relationship between heat transfer coefficients and mas velocity in constant rate drying.
   - (ii) Effect of air velocity, air humidity and air temperature on constant rate drying.
   - (iii) Calculation of falling rate drying when the rate of drying is a linear function of moisture ratio, X.

[Turn over

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PART II (50 Marks)

Q.1 is compulsory & answer any two from the following questions:

1. (i) Define relative volatility for a binary mixture. How it relates the vapor phase composition for a binary mixture? (ii) If in a binary mixture, α_{AB} =1.0 then estimate the vapour phase composition of A & B for $x_A = 0.35$ (iii) If in a binary liquid mixture of A & B at equilibrium with its vapor, $x_A = 0.4$ and $y_B = 0.3$, estimate α_{AB}. (iv) Show that, the starting point of the operating line for the rectifying section lies on the diagonal (v) Show that the end point of the operating line for the stripping section lies on the diagonal **5×2 = 10**

2. (a) What are the different feed conditions encountered in a ordinary tray distillation column? Discuss briefly about the q-line equation? Show that for the feed at its bubble point, q=1? If the feed at its dew point, what could be the value of q? (b) In a batch distillation unit, a liquid mixture containing 35 mole % n-heptane (A) and 65 mole % n-octane (B) ($\alpha_{AB} = 2.5$) with 65 mole % of the liquid distilled. Compute the composition of the distillate? **15+5 = 20**

3. Write short notes on **4×5 = 20**

   (i) Rectifying section operating line (ii) Stripping line (iii) Raoult's law (iv) Batch distillation

4. A rectification column is fed with 120 kmol/hr of a mixture containing 50 mole percent hexane and the rest is Octane at atmospheric pressure. The feed at its bubble point. The distillate is to contain 90 mole percent hexane and the bottoms 10 mole percent hexane with a reflux ratio=2.5. Calculate the Distillate and the Bottom product in kmol/hr and the number of theoretical trays needed for the separation. The equilibrium data for the given system is given below: **20**

Mole fraction of hexane (x)	1.00	0.7	0.4	0.2	0.05	0.00
Mole fraction of hexane(y)	1.00	0.94	0.78	0.54	0.18	0.00