

B.E. FOOD TECHNOLOGY AND BIO-CHEMICAL ENGINEERING THIRD YEAR SECOND SEMESTER - 2025

MASS TRANSFER OPERATION - II

Time : 3 Hours

Full Marks : 100

PART I (50 Marks)

Use Separate Answer scripts for each Part.

Psychrometric chart may be used for solving problems.

Answer question no.6 and any three from the rest.

1. Define relative humidity, dry bulb temperature and dew point with relevant expressions. How humid heat, humid volume and total enthalpy of an air-water vapour mixture are calculated? 5+10
2. An air-water vapour mixture has a dry bulb temperature of 65°C and a humidity of 0.035 kg water/ 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
3. 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
4. Show how constant rate drying can be expressed both by the heat and the mass transfer coefficients. Which expression is most preferred and why? 14+1
5. (a) What are wet basis and dry basis for calculation of moisture content of a food substance?
(b) A tunnel dryer is being designed for drying carrots from an initial moisture content of 73% to a final moisture content of 8%. The drying curve for the process indicates that the critical moisture content is 22%. All moisture contents are given on wet basis. The time for constant rate drying is 9 mins. Estimate the total drying time for the product. Assume that the falling rate period is represented by a straight line passing through the origin. Take 1kg of carrot as the basis for calculations. 5+10.
6. Answer any one. (5)
 - (i) Capillary Diffusion theory for drying in the falling rate period
 - (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.
 - (iv) Justify with an example that moisture content of a food substance can be bound and free at the same time.

Ref. No.: Ex/FTBE/PC/B/T/324/2025

B.E.FOOD TECHNOLOGY AND BIOCHEMICAL ENGINEERING

3rd Year, 2nd Semester EXAMINATION 2025

MASS TRANSFER OPERATIONS II (FTBE/PC/B/T/324)

PART II

Full Marks: 50

Answer Q.No. 3(compulsory) and any two from the following:

Q.1. (i) In a differential distillation unit, a liquid mixture containing 65% more volatile component A and the rest less volatile component B. If the composition of the residue liquid left behind equals to 39 mole % of A, estimate the fraction of liquid distilled and composition of the distillate. Assume relative volatility $\alpha_{AB} = 2$

(ii) "In a tray distillation column, the slope of the rectifying line is would be strictly positive and a pure fraction"

10+5 = 15

Q.2. In an ordinary tray distillation column, an equimolar saturated liquid mixture is introduced at the bubble point with a rate of 120 kmol/hr containing n-Hexane (A) and the rest n-Octane (B) with an expectation to achieve A at the top with 94 mole % and 6 mole % at the bottom. The reflux ratio is maintained 1.25 times the minimum reflux ratio assuming the relative volatility between A & B is equal to 2. Estimate (a) The minimum reflux ratio (b) amount of distillate and the bottom product (kmol/hr) (c) Equation of the operating lines in the rectifying and stripping section (d) slope of the operating lines at minimum reflux

4+3+5+3 =15

Q.3 A rectification column is fed with 60-40 mole% saturated liquid mixture of n-Hexane and n-Octane at atmospheric condition to achieve 90 mole% of Hexane at the top and 10 mole% at the bottom. The reflux ratio is 1.25 times the minimum reflux ratio to be maintained. Estimate the following (i) minimum reflux ratio (ii) actual reflux ratio (iii) No. of theoretical trays required (iv) Equation of the operating lines

Mole fraction of n-Hexane in liq., x	1.00	0.69	0.4	0.2	0.05	0.00
Mole fraction of n-Hexane in vap., y	1.00	0.93	0.78	0.54	0.18	0.00

3+2+7+3=15

Q.4. Write short notes on the following:

3×5 =15

(a) Effect of feed conditions on q-line (b) Rayleigh's equation (c) Difference between rectifying line and stripping line

Q.5 Justify the following statements mathematically (any three)

3×5 = 15

(i) " In a tray distillation unit, actual reflux ratio is neither be operated at minimum reflux ratio nor be operated at maximum reflux ratio"

(ii) "For a cold feed to a tray distillation unit, the slope of the q-line is always greater than 1"

(iii) " For superheated vapor feed to a tray distillation unit, the slope of the q-line always lie between 0 and 1"

(iv) "q-line is the locus of intersection of the operating lines in rectifying and stripping section of a tray distillation unit"