Name of the Examinations: B.E. FOOD TECHNOLOGY AND BIO-CHEMICAL ENGINEERING THIRD YEAR SECOND SEMESTER SUPPLEMENTARY EXAM - 2023

Subject : MASS TRANSFER OPERATION - II

Time : 3 Hours   Full Marks : 100

Group / Part (in case of half paper)

Instructions : Use Separate Answer scripts for each part. Use of Psychrometric chart is allowed.

Part A

Answer question no 5 and any two from the rest.

1. (a) Air has a dew point of 37^0C and a relative humidity of 58 %. Determine from the psychrometric chart (a) the absolute humidity (b) the dry bulb temperature and (c) the wet bulb temperature. 10

    (b) How is the water activity of a food substance defined? With a graph show the relationship between the water activity and rate of different deteriorative reactions in food. 10

2. (a) Using Ideal Gas Law equation deduce an expression for absolute humidity. What is the difference between dry bulb and wet bulb temperatures? What is dew point of an air-water vapour mixture? 7+2+1

    (b) What is the difference between evaporation and drying? Why is dehydration important for the food industry? How is drying characterised in the constant rate period? 3+3+4

3. A tunnel dryer is being designed for drying carrots from an initial moisture content of 75% to a final moisture content of 7%. The drying curve for the process indicates that the critical moisture content is 25%. All moisture contents are given on wet basis. The time for constant rate drying is 8 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 100 kg of apple as the basis for calculations.   20.

4. What is the difference between the total moisture content and free moisture content of a food substance? Show how constant rate of drying can be correlated to both heat and mass transfer coefficients. What is the empirical correlation between heat transfer coefficient and mass velocity of air when the air flow is parallel and perpendicular to the bed of solids. 3+13+4

5. Answer any one (10)
    (a) Operation of a tray dryer
    (b) Operation of a spray dryer
    (c) Diffusion Theory and Capillary Movement theory of moisture movement in the falling rate period.

[Turn over

B.E.FOOD TECHNOLOGY AND BIOCHEMICAL ENGINEERING EXAMINATION
(SUPPLEMENTARY),2023
(3rd Year, 2nd Semester)
MASS TRANSFER OPERATIONS II (FTBE/PC/B/T/324)

Time: Three hours   PART II   Full Marks: 50

Answer Q.No. 1(compulsory) and any two from the following:

Q.1. (i) For a binary mixture of volatile compounds, how relative volatility definition predicts the possibility of separation? In a batch distillation unit, a liquid mixture containing 45% more volatile component A and the rest less volatile component B. If the composition of the residue liquid left behind equals to 15 mole percent of A, estimate the fraction of liquid left behind the still after batch distillation is over. Assume relative volatility $\alpha_{AB} = 1.5$

(ii) In an ordinary tray distillation column, feed is introduced at the bubble point with a rate of 200 kmol/hr containing 50 mole percent Hexane and the rest Octane with a reflux ratio =4. The distillate is to contain 92 mole percent Hexane and 8 mole percent of hexane at the bottom. Estimate (a) amount of distillate and the bottom product (kmol/hr) (b) Equation of the q-line (c) Equation of the operating lines in the rectifying and stripping section   8+12=20

Q.2. (i) Show that for a binary mixture fed to a continuous distillation column at bubble point, the value of q is equal to 1.

(ii) In a continuous distillation column, 180 kmol/hr Benzene (A)-Toluene(B) mixture is fed with 40 mole percent A at its bubble point with a reflux ratio 2.5. The mole percent of A in the distillate and the bottom are 85 and 15, respectively. Find out the no. of theoretical trays required to achieve the duty. The equilibrium condition of A in liquid and vapor phase is as follows:

Mole fraction (A)in liquid	1.00	0.8	0.4	0.2	0.1	0.00
Mole fraction (A) in vapor	1.00	0.95	0.8	0.6	0.4	0.00

5+10 =15

Q.3. Write short notes on (Any three)   5×3 =15

(a) Raoult's law (b) q-line (c) Rayleigh method (d) Relative volatility (e) Reflux ratio

Q.4. (i) What are the different feed conditions maintained in an ordinary tray distillation column? How the slope of the feed line depends on the feed conditions?

(ii) Briefly discuss (with schematic representations, wherever necessary) the McCabe-Thiele method to estimate the theoretical tray requirement to achieve a particular duty for a given feed condition.   6+9 =15