Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

BE - SEMESTER– VI (NEW) EXAMINATION – WINTER 2021

Subject Code:3160501 Date:24/11/2021

Subject Name:Mass Transfer Operations II

Time:10:30 AM TO 01:00 PM Total Marks: 70

Instructions:

1. **Attempt all questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Figures to the right indicate full marks.**
4. **Simple and non-programmable scientific calculators are allowed.**

			Marks
Q.1	**(a)**	Define relative volatility. Discuss its importance.	**03**
	(b)	What is the effect of increasing pressure on separation of components in binary distillation column? Justify with appropriate y vs x diagram.	**04**
	(c)	100 moles of mixture of components A and B containing 60 mole % of A is subjected to a differential distillation at atmospheric pressure till the composition of A in the residue is 30%. Calculate the total moles of distillate and residue. Average relative volatility is constant at 2.25. Also draw an equilibrium diagram (y vs x diagram).	**07**
Q.2	**(a)**	Define: Reflux ratio, Total reflux, minimum reflux	**03**
	(b)	Write in brief," Thermosyphon reboiler, its applications and limitations"	**04**
	(c)	Compute the vapour liquid equilibria at constant pressure of 1 atm for the mixture of n- heptane and n-octane, which may be expected to form ideal solution.	**07**

Data:

B.P. of n-Heptane = 98.38 °C and B.P. of n-Octane = 125.2°C

Antoine equation and Antoine constants

$$\log_{10} P = A - \frac{B}{T + C}$$ where, P is in bar and T is in K

Component	A	B	C
n heptane	4.02832	1268.636	-56.199
n-octane	4.04867	1353.126	-63.633

OR

	(c)	Derive equation of q-line	**07**
Q.3	**(a)**	Define: Relative saturation, Percentage saturation, Dew point	**03**
	(b)	Discuss the classification of cooling tower.	**04**
	(c)	Explain the theory of adiabatic saturation temperature and derive the equation for adiabatic saturation temperature determination.	**07**

OR

Q.3	**(a)**	Compare forced draft and induced draft cooling tower.	**03**
	(b)	Explain the following terms for air-water system: (i) Absolute humidity (ii) Humid volume (iii) Humid heat (iv) Lewis Relation	**04**
	(c)	A mixture of gas B and benzene (A) is saturated at 1 std. atmosphere and 50 °C. Calculate the absolute humidity if B is (a) Carbon dioxide and (b) Nitrogen. Assume a mixture is saturated. (Refer Figure 1 for calculation)	**07**

Q.4 **(a)** Explain physical adsorption. **03**

(b) What is pressure swing adsorption (PSA)? Discuss PSA with industrial application **04**

(c) Using Freundlich equation, derive the following expression **07**

$$\left(\frac{Y_0}{Y_2}-1\right)=\left(\frac{Y_1}{Y_2}\right)^{\frac{1}{n}}\left(\frac{Y_1}{Y_2}-1\right)$$

for a two-stage counter current adsorption operation. Where Y_0, Y_1 and Y_2 represents initial, intermediate and final concentrations terms for an adsorption operation and 'n' is a constant of Freundlich equation.

OR

Q.4 **(a)** Explain chemical adsorption. **03**

(b) What do you mean by Ion Exchange? Describe techniques and application of ion exchange. **04**

(c) Write Freundlich equation and explain. Write material balance for a single stage adsorption and apply Freundlich equation in it. **07**

Q.5 **(a)** Discuss the working of freeze dryer with **03**

(b) List out the factors which affects the drying. Differentiate between drying and evaporation? **04**

(c) What is pressure swing adsorption (PSA)? With a neat and clean diagram discuss PSA with industrial applications and advantages. **07**

OR

Q.5 **(a)** Discuss in detail. "Types of moisture" with suitable figure. **03**

(b) A 25 cm x 25 cm x 1 cm flat sheet weighing 1.2 kg initially was dried from both sides under constant drying rate condition. It took 1500 sec for the weight of the sheet to reduce to 1.05 kg. Another 1 m x 1 m x 1 cm flat sheet of the same material is to be dried from one side only. Under the same drying rate condition, what is the time required for the drying (in sec) from its initial weight of 19.2 kg to 17.6 kg? **04**

(c) Derive equation for time required in constant and falling rate drying. **07**

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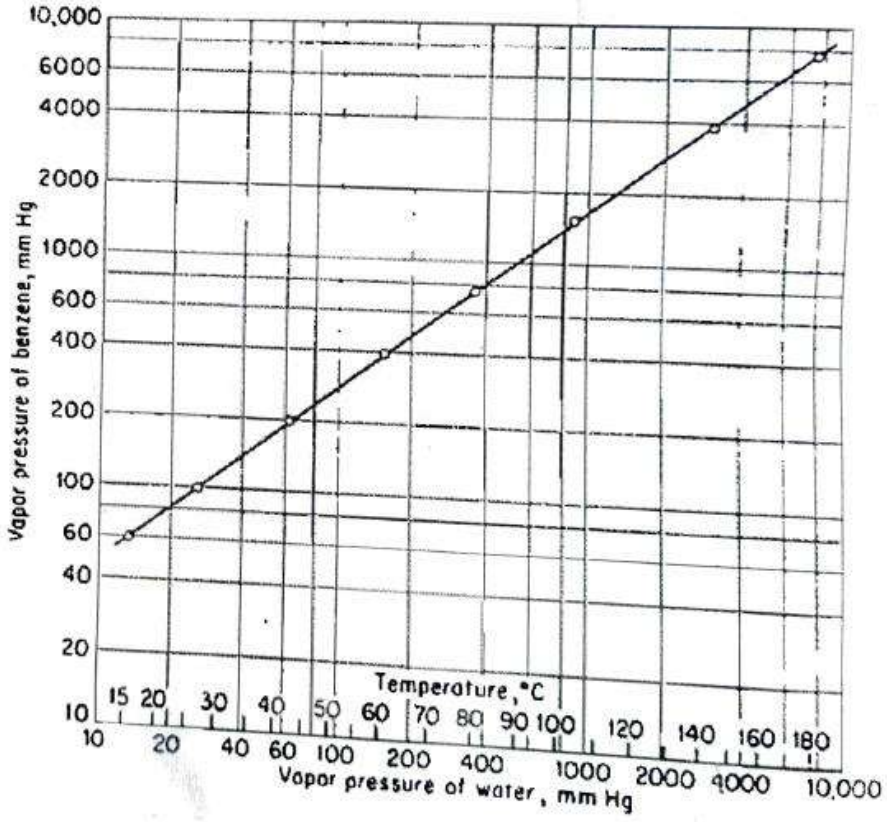
Vapor pressure of benzene, mm Hg
10,000
6000
4000
2000
1000
600
400
200
100
60
40
20
10
Temperature, °C
15 20 30 40 50 60 70 80 90 100 120 140 160 180
10 20 40 60 100 200 400 1000 2000 4000 10,000
Vapor pressure of water, mm Hg

Figure 1

Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

BE - SEMESTER–VI (NEW) EXAMINATION – SUMMER 2022

Subject Code:3160501 Date:01/06/2022

Subject Name:Mass Transfer Operations II

Time:10:30 AM TO 01:00 PM Total Marks: 70

Instructions:

1. **Attempt all questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Figures to the right indicate full marks.**
4. **Simple and non-programmable scientific calculators are allowed.**

MARKS

Q. 1 **(a)** Explain briefly optimum reflux ratio. **03**

(b) List out various types of reboiler used in industry. Explain any one in detail. **04**

(c) Write a short note on azeotropic distillation with suitable example. **07**

Q. 2 **(a)** Show that the relative volatility of an ideal binary system is equal to the ratio of vapor pressure of two components. **03**

(b) Define: (i) Humid volume (ii) Wet bulb temperature (iii) Bound moisture (iv) Unbound Moisture **04**

(c) A fractionating column separates a liquid mixture entering at 5000 kmol/h containing 50 mole % A and 50 mol % B into an overhead product of 95 mole % A and a bottom product of 96 mole % B. A reflux ratio of twice the minimum will be used and the feed enters at its boiling point. Determine the number of theoretical stages required and the location of feed point. **07**

Equilibrium Data:

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	0.710	0.83	0.88	0.93	1.0

OR

(c) 1000 kmol/hr of an ethanol-propanol mixture containing 65 mole percent ethanol is to be separated in a continuous plate column operating at 101.325 kPa total pressure. The desired terminal composition in terms of mole fraction of ethanol are $x_D = 0.90$ and $x_W = 0.1$. The feed is saturated vapour and total condenser is used. When the reflux flow rate is four times the amount of top product, find the number of theoretical plate required for the separation and location of feed plate. Relative volatility of ethanol-propanol system may be taken as 2.10 **07**

Q.3 **(a)** Define quantity ‘q’. Derive equation for q-line. **03**

(b) Compute the equilibrium data from following data at 760 mm Hg pressure and relative volatility. **04**

Vapour Pressure, A (mm Hg)	760	830	920	1060	1200	1360
Vapour Pressure, B (mm Hg)	200	350	420	550	690	760

(c) Discuss differential distillation and derive Rayleigh equation for a binary mixture. **07**

OR

Q.3 **(a)** State the various industrial applications of adsorption. **03**

(b) State the significance of Freundlich equation applicable to adsorption. **04**

(c) Explain principles of ion exchange and describe its various techniques and industrial applications. **07**

Q.4 **(a)** Explain various losses in cooling towers and explain why make water is required in cooling towers. **03**

(b) Classify various types of cooling towers with neat sketches. **04**

(c) Explain the concept of wet-bulb temperature curve and adiabatic saturation curve. Explain Lewis relation. **07**

OR

Q.4 **(a)** In a mixture of benzene (A) vapor and nitrogen (B) gas at a total pressure of 800 mmHg and temperature of 60˚ C, the partial pressure of benzene is 100 mmHg calculate the (i) Mole fraction of benzene, (ii) Molal absolute humidity and (iii) Absolute humidity. **03**

(b) Differentiate between physical adsorption and chemisorptions. **04**

(c) Explain mechanism of cooling in upper part and lower part of a cooling tower operating counter currently. **07**

Q.5 **(a)** Write a short note on sublimation drying. **03**

(b) Classify drying equipments. **04**

(c) What is critical moisture content? Derive the equations for time of drying for (i) Initial and final moisture content greater than critical moisture content (ii) Initial and final moisture content less than critical moisture content (iii) Initial moisture content greater than critical moisture content and final moisture content less than critical moisture content. **07**

OR

Q.5 **(a)** Write a short note on vacuum drum drier. **03**

(b) Explain hold up in Rotary Dryer. **04**

(c) A granular solid with dry bulk density of 1600 kg/m^3 being dried in a batch drier in air at 65˚ C, with a humidity of 0.005 kg water / kg dry air. The solid containing 0.5 kg water / kg dry solids are in 2.54 cm pans insulated so that mass and heat transfer occurs from top surface only. The solids are to be to a final moisture content of 0.02 kg water / kg dry solid and havecritical moisture contnt of 0.01 02 kg water / kg dry solid. air passes over the pans at a mass velocity of 1.7 kg/m^2 s. Heat transfer by conduction and radiation may be neglected. For this granular materials, equilibrium moisture content is zero. (i) Calculate the drying time required and (ii) What will be the drying time if air flow rate is increased to 2.5 kg/m^2 s. **07**

Psychrometric data: At 65˚ c dry bulb temperature and 0.005 kg water / kg dry air absolute humidity, wet bulb temperature = 26˚ C and λ_w = 2440 kJ/kg.

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