Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

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

Subject Code:2160501 Date:03/08/2021

Subject Name:Mass Transfer Operation - II

Time:02:30 PM TO 05:00 PM Total Marks: 70

Instructions:

1. **Attempt all questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Figures to the right indicate full marks.**

Q.1 **(a)** Draw a schematic diagram of the conventional fractionating column and explain how mass transfer occurs between two phases in the column. **03**

(b) Prove that Relative Volatility (α) is a vapor pressure ratio of two components of an ideal binary mixture. **04**

(c) 1000 kmol/h of an ethanol-propanol mixture containing 65 mole percent ethanol is to be separated in a continuous plate column operating 101.325 kPa total pressure. The desired terminal compositions in terms of mole fraction of ethanol are $x_D = 0.92$ and $x_W = 0.07$. The feed is saturated vapor and total condenser is used. When the reflux flow rate is four times the amount of top product, find the number of theoretical plates required for the separation. For a binary system ethanol-propanol equilibrium data are as follows: **07**

x	0	0.2	0.4	0.6	0.8	1.0
y	0	0.34	0.58	0.76	0.89	1.0

Q.2 **(a)** How acetic acid-water mixture can be separated using Azeotropic distillation? **03**

(b) What is the reflux ratio? Explain the minimum and total reflux ratio, How to calculate the minimum reflux ratio when feed is saturated vapor. **04**

(c) What is a flash distillation? Derive operating line equation for Flash Distillation operation. Draw operating line for following conditions. (a) Feed totally vaporized (b) No feed is vaporized. **07**

OR

(c) A batch distillation operation is carried out to separate a feed containing 150 moles of a binary mixture of A and B. The mole fraction of A in the feed is 0.8. The distillation progresses until the mole fraction of A in the residue decreases to 0.6. The equilibrium curve in this composition range may be linearized to $y^* = 0.7353x + 0.3088$. Here x and y are the mole fractions of the more volatile component A in the liquid and vapor phases respectively. Calculate the number of moles of residue. **07**

Q.3 **(a)** Explain following terms with reference to cooling tower (1) Range (2) Approach (3) Dew point temperature **03**

(b) Why cooling towers are used in chemical process industries, give the classification and explain in about cooling tower used in power plants. **04**

(c) An air (B)-water (A) sample has a dry bulb temperature 60°C and an absolute humidity of 0.03 kg-water vapor/kg-dry air. The system pressure is at 1 atmosphere absolute. Evaluate Determine following terms using psychometric chart. (1) % Relative Humidity (2) Dew point Temperature (3) Humid Volume (4) Humid Heat (5) Wet point Temperature. Vapor Pressure of water at dry bulb temperature = 100 mm Hg **07**

OR

Q.3 **(a)** Describe spray chambers shortly. **03**

(b) Discuss the concept of wet bulb temperature. **04**

(c) Explain the theory of adiabatic saturation temperature and derive the equation for adiabatic saturation temperature determination. **07**

Q.4	**(a)**	Explain Adsorption isotherm and hysteresis.	**03**
	(b)	Discuss types of adsorption, nature of adsorbents, and list-out important adsorbents generally used in industry.	**04**
	(c)	With reference to breakthrough curve of adsorption in a fixed bed, deduce the expression to calculate the degree of saturation of the adsorbent bed.	**07**

OR

Q.4	**(a)**	What do you mean by Ion Exchange? Describe the techniques and application of ion exchange.	**03**
	(b)	Discuss the concept of Pressure Swing Adsorption (PSA).	**04**
	(c)	Using Freundlich equation, derive the following expression $\left(\frac{Y_0}{Y_2}-1\right)=\left(\frac{Y_1}{Y_2}\right)^{1/n}\left(\frac{Y_1}{Y_2}-1\right)$ 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.	**07**

Q.5	**(a)**	Define: Equilibrium moisture, free moisture, critical moisture	**03**
	(b)	Discuss the factors on which rate of drying depends.	**04**
	(c)	Derive the relation to determine the time needed for constant & falling rate period of the batch drying operations.	**07**

OR

Q.5	**(a)**	Classify driers and discuss selection criteria for dryers.	**03**
	(b)	Explain the working of a spray dryer with a figure. Also, discuss the benefits of spray drying.	**04**
	(c)	A 100 kg batch of granular solids containing 30% moisture is to be dried in a tray dryer to 16% moisture by passing a current of air at 350 K across its surface at a velocity of 1.8 m/s. If the constant drying rate under these conditions is 0.7×10^{-3} kg/m^2.s, if the critical moisture content is 15%, calculate the drying time. Given that the surface area available for drying is 0.03 m^2 /kg dry solid.	**07**

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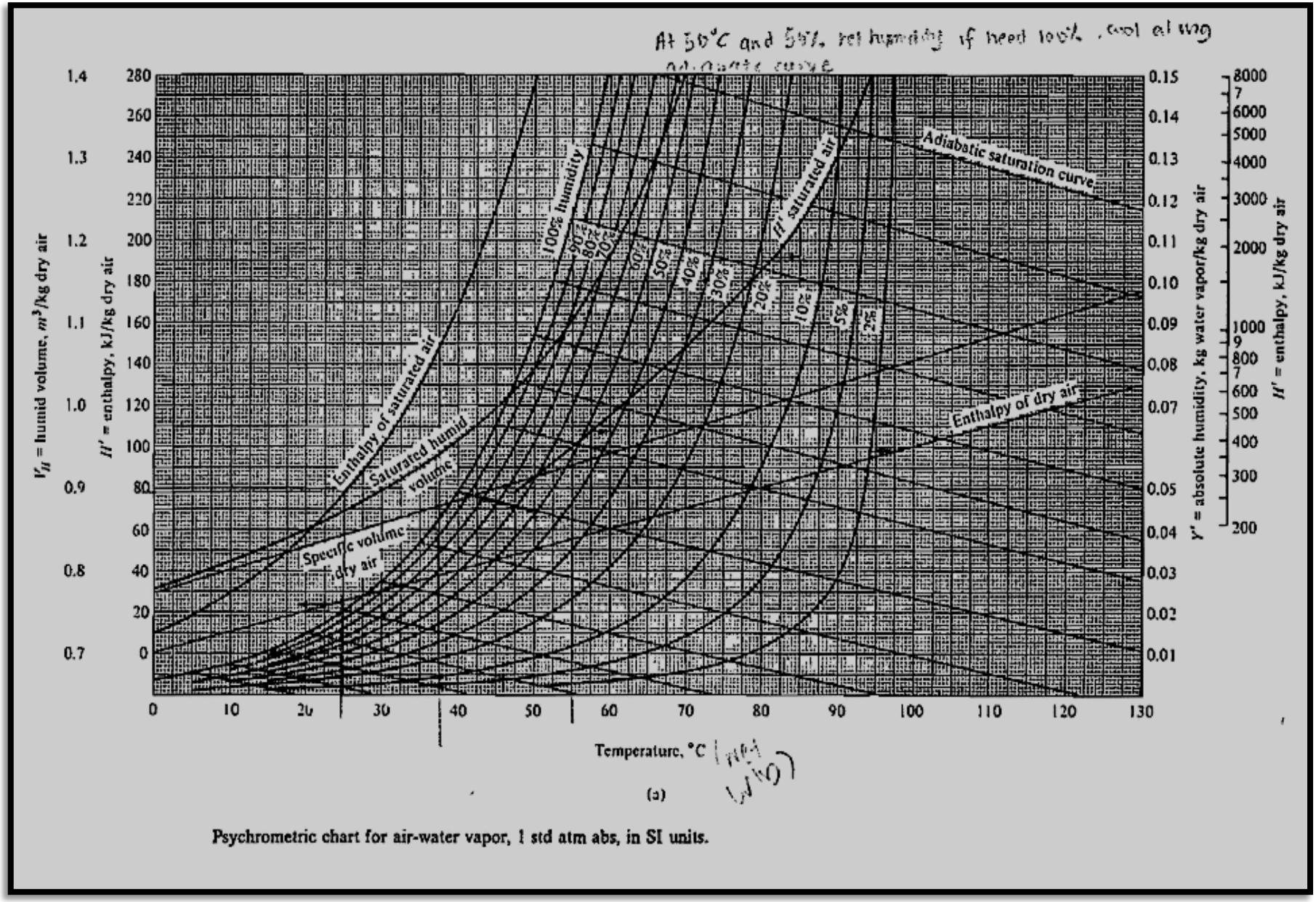

Psychrometric chart for air-water vapor, 1 std atm abs, in SI units.