Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

BE - SEMESTER–VI (NEW) EXAMINATION – SUMMER 2023

Subject Code:3160501 Date:04-07-2023

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: 1) Grosvenor Humidity 2) Critical Moisture 3) Bound Moisture	**03**
	(b)	Define volatility. Prove that: $y = \alpha x/(1+(\alpha-1)x)$	**04**
	(c)	Differentiate between extractive and azeotropic distillation and discuss its selection criteria. Also explain extractive distillation at length.	**07**
Q.2	**(a)**	Explain adsorption with example by citing proper industrial examples and also enlist commonly used adsorbents and their characteristics.	**03**
	(b)	Define quantity 'q'. Derive equation for q-line.	**04**
	(c)	A continuous distillation column is used to separate a feed mixture at its boiling point, containing 24 mole % acetone and rest methanol into a distillate product containing 77 mole % acetone and residue product containing 5 mole % acetone. A reflux ratio of twice the minimum is to be used. The overall plate efficiency is 60 %. Determine number of plates required for the separation.	**07**

x	0.05	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
y	0.102	0.186	0.322	0.428	0.513	0.586	0.656	0.725	0.82	0.9

OR

	(c)	A mixture of benzene and toluene having 40 % benzene is to be separated at 200 kmol/h into a top product having 95 % benzene and bottom product with 4% of it. Column is operated at total reflux condition during start up period. Determine number of stages if its operated at total reflux condition. Calculate the same using Fenske equation. The average volatility is 2.5.	**07**
Q.3	**(a)**	At higher pressure, distillation is difficult. True or false? Justify.	**03**
	(b)	Explain various losses in cooling towers and explain need of make-up water in cooling towers.	**04**
	(c)	Explain principle and working of rotary dryer with neat sketch.	**07**

OR

Q.3	**(a)**	In perfumery industries, steam distillation is preferable. True or false? Justify the statement. Also cite few examples of steam distillation.	**03**
	(b)	Wet bulb temperature is generally less than dry bulb temperature. True or False? Justify. Also define Humid Heat and Humid Volume.	**04**
	(c)	Describe the different zones in continuous drying operation and derive equation for retention time in continuous dryer at low temperature.	**07**
Q.4	**(a)**	List characteristics of ideal solutions and explain Raoult's law.	**03**

	(b)	Define range and Approach with reference to cooling towers. Determine range and approach of cooling tower if its inlet temperature is 41 ℃ and outlet water temperature is 31 ℃. Wet bulb temperature is 24 ℃.	**04**
	(c)	A wet solid is to be dried from 40 % to 10 % moisture in 5 hrs. If the equilibrium and critical moisture content is 5 % and 15 % respectively. i) Estimate the excess time needed to dry the solid to 8 % moisture under the same conditions. (All the moisture contents are on dry basis) ii) Compare the time required to dry the material from 40 % to 10 % moisture if moisture content is on wet basis, if other conditions remain the same.	**07**

OR

Q.4	**(a)**	Derive equation for falling rate period if rate is proportional to square of moisture content.	**03**
	(b)	A mixture of nitrogen and acetone vapor at 800 mm Hg total pressure and 25℃ temperature has 80 % saturation. Calculate molal and absolute humidity, partial pressure of acetone. Also determine relative humidity if vapor pressure of acetone is 190 mm Hg.	**04**
	(c)	Classify cooling towers. Compare induced draft cooling tower with forced draft cooling tower.	**07**
Q.5	**(a)**	Discuss the effect of temperature and pressure on adsorption.	**03**
	(b)	Explain principles of ion exchange in brief. Also list its applications.	**04**
	(c)	Explain Freundlich equation. Derive the relation for single stage adsorption using the Freundlich equation.	**07**

OR

Q.5	**(a)**	At 30 °C the amount of acetone adsorbs at partial pressure of 10 and 100 mm Hg are 0.1 and 0.4 kg Acetone per kg activated carbon respectively. Assume Langmuir isotherm describe the adsorption of acetone on activated carbon. Determine the amount of acetone adsorbed at a partial pressure of 50 mm Hg and 30 °C.	**03**
	(b)	Explain equilibrium with reference to adsorption. Also discuss hysteresis.	**04**
	(c)	Define adsorption. Compare physical and chemical adsorption. Discuss about pressure swing adsorption (PSA) in detail and also explain the industrial applications of PSA by stating proper examples.	**07**

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