Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

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

Subject Code:3160501 Date:02-12-2023

Subject Name:Mass Transfer Operations 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.**
4. **Simple and non-programmable scientific calculators are allowed.**

			MARKS
Q.1	**(a)**	Define: 1) Lewis Relation 2) Chemisorption 3) Equilibrium moisture	**03**
	(b)	Explain the effect of increasing pressure on separation of components in binary distillation column? Justify with appropriate T-x.y and y vs x diagram.	**04**
	(c)	A bubble cap fractionating column consisting of 12 plates working at an average efficiency of 75% is being used to distill 1000 kg/hr of aqueous methanol at its bubble point entering the tower. The feed, overhead product and bottom product are 50 mole %, 90 mole% and 10 mole% methanol respectively. A total condenser is provided. The reflux is sent at its saturation temperature. If the reflux ratio is 1.7 times the minimum. Calculate ideal plates and check whether the column available is satisfactory. The VLE data are:	**07**

x	8	10	20	30	40	50	70	80	95
y	36.5	41.8	57.9	66.5	72.9	77.9	87	95.8	97.9

Q.2	**(a)**	Define: 1) Minimum Reflux Ratio 2) Quantity ‘q’ 3) Boil up Ratio	**03**
	(b)	Prove that ‘Relative Volatility (α) is the ratio of vapor pressure of the components’	**04**
	(c)	A mixture of benzene and toluene containing 60 mole% benzene is to be separated to give a product of 95 mole% benzene and bottom product containing 10 mole% benzene. The feed enters a column at its bubble point. It is proposed to operate the column with reflux ratio of 2.5. Calculate number of theoretical plates needed by Mccabe-Thiele method and position of feed plate. The vapor liquid equilibrium data are given as below:	**07**

x	0	0.05	0.1	0.2	0.3	0.4	0.5
y	0	0.13	0.21	0.375	0.5	0.6	0.7

x	0.6	0.7	0.8	0.9	1.0
y	0.77	0.83	0.9	0.95	1.0

OR

	(c)	A feed of 60 mole% hexane and 40 mole% octane is fed to a pipe still through a pressure reducing valve into a flash disengaging chamber. The vapour and liquid leaving the chamber are assumed to be in equilibrium. If 50 mole% of feed	**07**

is vaporized, find the composition of the top and bottom products. Equilibrium data is given below:

x, mole fraction of hexane in liquid	1.0	0.69	0.40	0.192	0.045	0
Y, mole fraction of hexane in vapour	1.0	0.932	0.78	0.538	0.1775	0

Q.3 **(a)** Define: 1) Relative humidity 2) Percentage saturation 3) Humid Heat **03**

(b) 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) Nitrogen and (b) Carbon dioxide. Vapor pressure of benzene at 50 °C is 275 mmHg. **04**

(c) Explain classification of cooling tower and brief induced draft cooling tower with neat sketch. **07**

OR

Q.3 **(a)** Define: 1) Wet bulb temperature 2) Dew point 3) Humid volume **03**

(b) In a mixture of benzene vapor (A) and nitrogen gas (B) at a total pressure of 800 mmHg and a temperature of 60 °C., the partial pressure of benzene is 100 mmHg. Calculate the a) Mole fraction of benzene b) Molal absolute humidity c) Absolute Humidity. **04**

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

Q.4 **(a)** Define: 1) Adsorption hysteresis 2) Azeotrope 3) Total Reflux **03**

(b) Explain pressure swing adsorption (PSA) and discuss its industrial application **04**

(c) Using Freundlich equation, derive the expression for a two-stage counter current adsorption operation. **07**

OR

Q.4 **(a)** List the principal adsorbents which is generally used in adsorption. **03**

(b) Explain the adsorption wave in adsorption operation. **04**

(c) Define Ion Exchange? Describe techniques and applications of ion exchange and list out the factors on which rate of ion exchange is dependent. **07**

Q.5 **(a)** Define: 1) Bound moisture content 2) Unbound moisture content 3) Free Moisture content **03**

(b) Explain Tray dryer and give its applications **04**

(c) A wet solid is to be dried from 35% to 10% moisture under the constant drying condition in 5 hours. If the equilibrium moisture content is 4% and the critical moisture content is 14%, how long it will take to dry solids to 6% moisture under the same conditions? **07**

OR

Q.5 **(a)** Define: 1) Critical moisture content 2) moisture content on wet **03**

basis 3) moisture content on dry basis

(b) Derive expression of time of drying in the constant rate period in drying operation. **04**

(c) Find out the rate of drying and moisture content from the following data: **07**

Weight of wet saw dust	Weight of saw dust after drying	Time (hour)
250 gm	230 gm	0.5
250 gm	215 gm	0.75

Dimensions of tray is 10 cm x 10 cm

Weight of the dry saw dust on tray is 150 gm.

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