

PARUL UNIVERSITY
FACULTY OF ENGINEERING & TECHNOLOGY
B.Tech.Winter, 2019 – 20 Examination

Semester: 5**Subject Code: 03103301****Subject Name: Mass Transfer Operations-II****Date: 05/12/2019****Time: 10:30 am to 01:00pm****Total Marks: 60****Instructions:**

1. All questions are compulsory.
2. Figures to the right indicate full marks.
3. Make suitable assumptions wherever necessary.
4. Start new question on new page.

Q.1 Objective Type Questions - (Fill in the blanks, one word answer, MCQ) (All are compulsory) (Each of (15) one mark)

- 1.The slope of the rectifying section in distillation column is always _____ than 1.
- 2.The most popular solvent for oil extraction is:
- 3.Flash distillation is also known as:
- 4.The Type II ternary systems can be converted into Type I ternary systems by:
- 5.The reboiler is also considered as an ideal stage because _____.
- 6.When the boiling point of a liquid mixture is lower than any of its constituents, it is called as: _____ azeotrope.
- 7.The expression for relative volatility is:
- 8.The two factors which effect the rate of leaching are:
9. The expression of Raoult's Law is given as:
- 10.The equation of the feed-line is distillation is:
- 11.When the feed to a distillation column is a saturated liquid, the slope of the feed line is:
(a) Zero
(b) Unity
(c) Infinity
(d) Five
12. Fenske equation determines the:
(a) Maximum number of ideal plates
(b) Height of the distillation column
(c) Minimum number of theoretical plates
(d) Optimum reflux ratio
- 13.The apex of an equilateral-triangular coordinate in ternary liquid system represents:
(a) Pure component
(b) Binary mixture
(c) Ternary mixture
(d) Insoluble mixture
- 14.Freundlich's isotherm applies to the adsorption of solute from:
(a) Dilute solutions over a small conc. range
(b) Gaseous solution at high temperature
(c) Concentrated solution
(d) None of these
- 15.The critical moisture content in case of drying indicates:
(a) Beginning of falling rate period
(b) Beginning of constant rate period
(c) End of falling rate period
(d) None of these

Q.2 Answer the following questions. (Attempt any three)**(15)**

- A) Explain the different types of moisture in a wet solid? Also draw the diagram.
- B) Derive the equation for batch distillation (Rayleigh distillation) with complete integration.
- C) What are the characteristics and properties of adsorbent?
- D) What are the classification of solid-liquid extraction systems?

Q.3 A) Explain Total Reflux, Minimum Reflux and Optimum Reflux ratio.**(07)**

- B) What are Langmuir and Freundlich's isotherm? The following data are reported on adsorption of pure propane on activated carbon at different temperatures and pressure: **(08)**

T = 394 K		T = 422 K	
p	q	p	q
7.067	0.7099	13.07	0.6798
38.67	1.677	41.73	1.264
83.21	2.238	71.07	1.611
98.54	2.37	96.27	1.831
99.97	2.4	99.97	1.894
303.4	3.251	313.7	2.785
482.6	3.599	493	3.144

where, p = pressure of Propane in kPa; q = Amount of propane adsorbed at equilibrium (millimol/ g carbon).

- (a) Draw the adsorption isotherms q vs p at the above temperatures.
- (b) Draw the Langmuir and the Freundlich's isotherms, also find the value of their respective slope and intercept.

OR

- B) A wet solid is to be dried from 35% to 10% moisture under constant drying conditions 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? **(08)**

All values given above are in wet basis.

Q.4 A) A stream of an aqueous methanol (CH₃OH) having 45 mol% CH₃OH is to be separated into a top product having 96 mol% CH₃OH and a bottom liquid having 4 mol% CH₃OH. The feed is at its bubble point and the operating pressure is 101.3 kPa. A reflux ratio of 1.5 is to be used. Determine: **(07)**

- (i) The number of ideal stages.
- (ii) Number of real stages if the overall stage efficiency is 40%.

The equilibrium and bubble point data for methanol-water system at 101.3 kPa is given as:

<i>x</i>	0	0.02	0.04	0.06	0.08	0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	0.95	1.0
<i>y</i>	0	0.134	0.23	0.304	0.365	0.418	0.579	0.665	0.729	0.779	0.825	0.87	0.915	0.958	0.979	1.0
<i>Temp.</i>	100	96.4	93.5	91.2	89.3	87.7	84.4	78.0	75.3	73.1	71.2	69.3	67.6	66	65	64.5

OR

A) Derive the McCabe-Thiele Method for determining the number of trays, starting from the mass and energy balances for Rectifying and Stripping sections of distillation column. (07)

B) One thousand kilograms of an aqueous solution containing 35 mass% trimethyl amine (TMA) and 65 mass% water is to be extracted using benzene as solvent. A three-stage crosscurrent extraction scheme is to be used. The amounts of solvent (98% benzene, 2% TMA) to be used in successive stages are 815kg, 950 kg and 2625kg. Determine the fraction of the solute removed if the stages are ideal. (08)

The compositions of the raffinate and the extract as well as the tie line data are as follows (A: water, B: Benzene, C:TMA)

Water-rich phase:	x_B	0.004	0.006	0.01	0.02	0.03	0.036	0.07	0.13
	x_C	0.05	0.10	0.15	0.20	0.35	0.30	0.35	0.40
Benzene-rich phase:	y_B	0.95	0.90	0.84	0.78	0.71	0.63	0.50	0.26
	y_C	0.05	0.10	0.15	0.20	0.25	0.30	0.35	0.40
Tie-line data:	x_C	0.04	0.083	0.13	0.215	0.395			
	y_C	0.035	0.068	0.09	0.145	0.31			