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B.M.S. College of Engineering, Bengaluru-560019

Autonomous Institute Affiliated to VTU

June 2025 Semester End Main Examinations

Programme: B.E. **Semester: V**

Branch: Chemical Engineering **Duration: 3 hrs.**

Course Code: 23CH5PCMT2 / 22CH5PCMT2 **Max Marks: 100**

Course: Mass Transfer - II

Instructions: 1. Answer any FIVE full questions, choosing one full question from each unit.
2. Missing data, if any, may be suitably assumed.

Important Note: Completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages. Revealing of identification, appeal to evaluator will be treated as malpractice.

		UNIT - I	CO	PO	Marks
1	a)	A packed tower is designed to recover 98% carbon dioxide from a gas mixture, containing 10 % carbon dioxide and 90 % by volume air, using water. A relation $y' = 14x'$ can be used for equilibrium conditions where: $y' = \frac{\text{kg } CO_2}{\text{kg dry air}}$ and $x' = \frac{\text{kg } CO_2}{\text{kg water}}$. The water to gas rate is kept 30% more than the minimum value. Calculate the actual mole ratio of water to solute – free gas.	CO1	PO2	**10**
	b)	Elucidate with a neat sketch the construction and working principle of a packed column.	CO2	PO3	**10**
		OR			
2	a)	Derive an equation for finding out the height of a packed column operating in a counter current mode.	CO2	PO3	**10**
	b)	Benzene is to be recovered from coal gas by scrubbing it with wash oil as an absorbent. The coal gas contains 2 % by volume of benzene and is to be fed at a rate of 855m^3/h and 95 % removal of benzene is required. The operating temperature and pressure are 299.7 K and 106.658 kPa. The wash oil has an average molecular weight of 260 and contains 0.005 mole fraction benzene as it enters the absorber. Calculate the minimum circulation rate of the wash oil. The equilibrium relationship at the given conditions is given by $\frac{Y}{1+Y} = 0.125\frac{X}{1+X}$, where $Y = \frac{\text{moles benzene}}{\text{mole dry coal gas}}$ and $X = \frac{\text{moles benzene}}{\text{mole dry free wash oil}}$.	CO1	PO2	**10**
		UNIT - II			
3	a)	The vapour pressures of n-Hexane and n-Octane are given below at a constant pressure of 101.3 kPa.	CO1	PO2	**10**

T , ℃	68.7	79.4	93.3	107.2	121.1	125.6
T , K	341.7	352.4	366.3	380.2	394.1	398.6
p^{s}_{Hexane} , kPa	101.3	136.6	197.3	283.9	399.9	455.9
p^{s}_{Octane} , kPa	16.1	23.1	37.1	57.8	87.2	101.3

Generate VLE data and construct a plot the same.

	b)	Briefly explain the principle of flash evaporation with a neat sketch.	*CO2*	*PO3*	**10**
		OR			
4	a)	A liquid mixture containing 40 mole % benzene and 60 mole % toluene is subjected to the flash distillation at a separator pressure of 101.325 kPa to vaporize 50 mole % of the feed. What will be the equilibrium composition of the vapour and liquid?	*CO1*	*PO2*	**10**
	b)	Discuss about the McCabe-Thiele method for obtaining theoretical plates. (Including Assumptions, stepwise procedure and Limitations).	*CO4*	*PO2*	**10**
		UNIT - III			
5	a)	Write briefly about the procedure to determine the number of theoretical plates required in the distillation column using the Ponchon Savarit method.	*CO4*	*PO2*	**10**
	b)	What is an azeotrope? Give an example of an azeotropic system. How can this azeotrope mixture can be separated?	*CO4*	*PO2*	**10**
		OR			
6	a)	Define the following with the help of their expressions i. Overall efficiency or Overall plate efficiency ii. Murphree efficiency iii. Murphree local or point efficiency	*CO1*	*PO2*	**10**
	b)	Discuss about extractive distillation with a neat diagram	*CO3*	*PO4*	**10**
		UNIT - IV			
7	a)	Elucidate, triangular diagram for a ternary system with one pair partially miscible.	*CO1*	*PO2*	**7**
	b)	With a neat sketch, explain briefly the continuous mixer-settler assembly.	*CO2*	*PO3*	**7**
	c)	Iodine is to be extracted from its saturated aqueous solution using carbon disulphide. The distribution of iodine between carbon disulphide and water at equilibrium may be given as	*CO1*	*PO2*	**6**

x	0	0.05	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
y	0	0.13	0.21	0.37	0.5	0.6	0.7	0.77	0.83	0.9	0.95

			$K = \frac{y^*}{x} = 588.2$; Were, $y^* = \frac{g\ of\ iodine}{l\ of\ carbon\ disulphide}$ and $x = \frac{g\ of\ iodine}{l\ of\ water}$ i. Calculate the concentration of iodine in the aqueous phase when, 1 litre of a saturated aqueous solution at 293 K containing 0.3 grams of iodine per one litre of water, is contacted with 50 ml of carbon disulphide by stirring. ii. Repeat the calculation for two ideal extractions using 25 ml of solvent carbon disulphide each time.			
			OR			
	8	a)	Briefly explain the selection criteria for solvent to be used for LLE.	*CO1*	*PO 2*	**7**
		b)	Elucidate with a neat sketch the construction of rotating-disk contactor.	*CO2*	*PO3*	**7**
		c)	A solution of picric acid in benzene contains 30 grams of picric acid per litre. 1 litre of this solution is to be shaken with water at 291 K to reduce the picric acid concentration to 4 grams/litre in the benzene phases. Calculate the quantity of water needed. Molecular weight of picric acid is 229, and the distribution coefficient K is given by $K = \frac{C_E}{C_R} = \frac{\text{Concentration of picric acid in benzene } \left(\frac{\text{mol}}{\text{L}}\right)}{\text{Concentration of picric acid in water } \left(\frac{\text{mol}}{\text{L}}\right)} = 0.548$	*CO3*	*PO 4*	**6**
			UNIT - V			
	9	a)	What is the principle of leaching? Give the schematic representations of counter current, co current and cross current leaching operation.	*CO4*	*PO2*	**10**
		b)	With a neat diagram explain the working principle of Dorr thickener.	*CO2*	*PO3*	**10**
			OR			
	10	a)	Explain the construction and operation of Boll man extractor.	*CO2*	*PO3*	**10**
		b)	Illustrate the graphical procedure to determine the number of stages in multistage counter current leaching.	*CO4*	*PO2*	**10**

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