Reg. No.



MANIPAL INSTITUTE OF TECHNOLOGY

MANIPAL (A constituent unit of MAHE, Manipal)

IV SEMESTER B.TECH. (CHEMICAL ENGINEERING) END SEMESTER EXAMINATIONS, APRIL 2019 SUBJECT: MASS TRANSFER-I [CHE 2203] REVISED CREDIT SYSTEM (26/04/2019)

Time: 3 Hours

MAX. MARKS: 50

Instructions to Candidates:

☑ Answer **ALL** the questions. ☑ Missing data may be suitably assumed.

1 A .	Explain penetration theory of interfacial mass transfer along with governing								
	equations?	3							
18.	An ethanol (A)-water (B) solution in the form of stagnant film 6.0 mm thick at 293 K is in contact at one surface with an organic solvent in which ethanol is soluble and water is insoluble. Hence N _B = 0. At point 1 the concentration of the ethanol is 16.8 wt% and the solution density is ρ_1 =972.8 kg/m ³ . At point 2 the concentration of ethanol is 0.740*10 ⁻⁹ m ² /s								
	Calculate the steady state flux N_{A} .								
1C.	Calculate the steady state flux N _A . • A 1-m square thin plate of solid naphthalene is oriented parallel to a stream of air flowing at 20 m/s. The air is at 310 K and 101.3 kPa. The naphthalene remains at 290 K; at this temperature the vapor pressure of naphthalene is 26 Pa. The other data are: Diffusivity of naphthalene vapor in air : 0.069 cm ² /s Dynamic viscosity of air : 0.0185 centiPoise Density of air : 1.18 kg/m ³ (a) The average mass transfer coefficient over the flat plate (b) Estimate the moles of naphthalene lost from the plate per hour, if the end effects can be ignored. The following correlation may be used for estimating the mass transfer coefficient Sh=0.664 Re ^{0.5} Sc ^{0.333} (Laminar) - Re < 3*10 ⁵								
2A	With appropriate schematic sketch, material balance equations and graphical construction, explain how would you calculate the number of ideal stages in a multistage countercurrent operation when transfer occurs from R to E?	3							
2B.	Explain two-phase resistance theory with appropriate plot and brief discussion?	3							
2C.	In an experimental study of the absorption of ammonia in water at 1 atm, the value of the overall gas phase coefficient (K_G) was found to be 1.002 kmol/hr.m ² .atm. At one point in the column gas contains 8 mol% of NH ₃ and liquid phase concentration was 0.14125 kmol of NH ₃ per m ³ of solution. The temperature was 20 ^o C and pressure 1 atm. 85% of the total resistance was found to be in gas phase. If								

	$p_{Ai}^* = mc_{Ai}$, Where $m = 0.0134 \frac{\text{atm}}{1 \text{ trm} 1/m^3}$.									
	(a) Find the liquid side coefficient k									
	(a) the figure side coefficient, κ_{L}									
	(c) Interfacial concentration, p_{Ai} and c_{Ai} Hint: $\frac{1}{K_G} = \frac{1}{k_G} + \frac{1}{K_G}$						$\frac{1}{k_G} + \frac{m}{k_L}$			
3A.	A flue gas containing 15% CO ₂ and rest O ₂ and N ₂ by volume is scrubbed in a tray									
	tower at 1.2 atm and 25 ^o C with ethanolamine solution. The equilibrium data for the									
	system is given below:									
	Moles of CO ₂ per mole of	0.058	0.06	0.062	0.064	0.066	0.068	0.07		
	solution (X)									
	Partial Pressure of CO ₂ ,	5.6	12.8	29	56	98.7	155	232		
	mm Hg									
	The scrubbing liquid contains 0.058 moles CO ₂ per mole of solution and gas leaving									
	the scrubber contains 2% by vol. of CO_2 . Determine the number of theoretical									
	stages required for 1.5 times the minimum ratio. 5									
3B.	Explain choice of solvent for absorber columns?									
3C.	Differentiate between sieve plate tower and packed tower?									
4A.	List any four industrial adsorbent. Indicate their specific application									
4B.	Explain break through curves in adsorption?									
4C.	Activated carbon is used to recover benzene from nitrogen-benzene vapor mixture.									
	A nitrogen-benzene mixture at 306 K and 1 atm containing 1 % benzene by volume									
	is to be passed at the rate of (G_s =1.014 kg/s) over a pure activated carbon so as to									
	remove 85% of the benzene from the gas. Nitrogen is not adsorbed.									
	follows:									
	kg benzene/kg dry carbon (X) 0 0.087 0.139 0.174 0.2							0.226		
	Partial pressure of benzene,mm Hg			0.95	1.63	2.	18	3.26		
	Determine the minimum an	nount of	carbon	required	per hour	for				
	(a) A continuous counter current operation adsorber (b) Two stage cross current operation adsorber									
	(c) Which operation do you suggest and why?									
5A.	Derive relation between gas phase humidity and adiabatic saturation temperature.									
	$\frac{(H_1 - H_s)}{C_{s1}} = -\frac{C_{s1}}{C_{s1}}$									
	$(T_{G1}-T_S)$ λ_S									
	Clearly state the assumptions and label the notations used.									
5B.	Draw and explain the concentration (in terms of humidity) profile plot at the top of									
	the cooling tower for liquid and air interface?									
	(a) Show the directions of the latent heat and sensible heat in profile plot									
5C	An air-water vapour mixture at 1 atmosphere has a dry bulb temperature of $64.5^{\circ}C$									
	and wet bulb temperature of 31.1 [°] C. If Latent heat of vaporization is 579.4 kcal/kg,									
	air humidity is 0.018 and saturation humidity is 0.031, Calculate the Psychrometric									
	ratio 3									