

JK LAKSHMIPAT UNIVERSITY, JAIPUR

INSTITUTE OF ENGINEERING AND TECHNOLOGY

End Term Examination (Backlog), November 2017

B. Tech in Chemical Engineering, Semester V

Roll No.....

CHE504: SEPARATION PROCESSES

Time: 3 hours

Max. Marks: 100

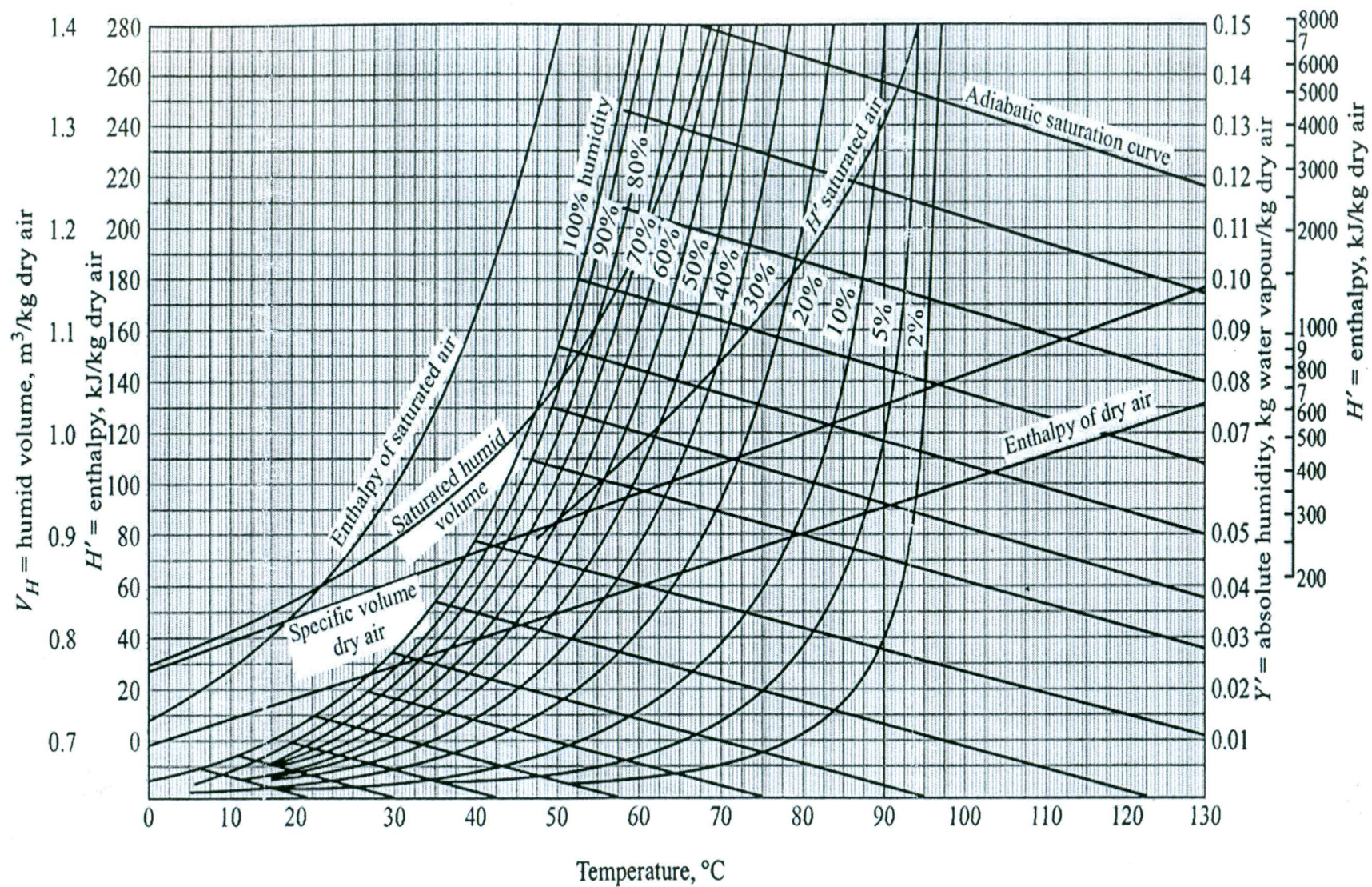
Instructions to students:

1. Do not write anything other than your roll number on question paper.
2. Assume suitable data wherever required and mention it clearly.
3. Writing appropriate units, nomenclature, and drawing neat sketches/schematics/ flow chart wherever, required are an integral part of the answer.
4. If second part of Q.9 is attempted then attach the figure sheet of question paper with your answer sheet.

Q.1A	Objective type multiple choice questions (10 questions @ 1 mark)	10
i.	In which of the following cases is the separation of the solute (C) from the carrier (A) using solvent (B) impossible? (i) A, B and C are completely miscible (ii) A-C and B-C pairs are completely miscible (iii) A-B is partly miscible. (iv) none of these.	
ii.	Define psychrometric ratio.	
iii.	If the 'approach' in a cooling tower is smaller, the height of the packed section will be: (a) less (b) more (c) remain unaffected	
iv.	Partial recirculation of warm and humid air leaving a tower is more likely to occur in (i) natural draft tower (ii) forced draft tower (iii) induced draft tower (iv) all of above	
v.	Consider constant-rate drying of a moist solid on a tray. Substantial heat transfer to the solid occurs from the tray floor. If the wet bulb temperature of the drying gas is T_w and the surface temperature of the solid is T_s , then (i) $T_s < T_w$ (ii) $T_s = T_w$ (iii) $T_s > T_w$	
vi.	Write an equation for the calculation of enthalpy of a stream of moist air at 1 atm pressure and of humidity H and temperature $T_G^\circ\text{C}$.	
vii.	Which type of tower is most favored in the chemical process industries? (a) induced draft tower (b) hyperbolic tower (c) spray tower without a fill (d) none of these	

viii.	What is 'critical moisture content' in drying rate curve?	
ix.	Write name of equipment's used for leaching?	
x.	Differentiate between dry bulb temperature and wet bulb temperature.	
Q.2	Short answer type questions (4 questions @ 2.5 marks)	10
(i)	Differentiate Natural Draft, forced draft and induced draft cooling tower?	
(ii)	What do you understand by 'Range' and 'Approach' in cooling tower?	
(iii)	Name a few industries have a large cooling load	
(iv)	Give few industrial examples of drying?	
Q.3A	What is leaching? Explain with an industrial example. Write different factors influencing the rate of extraction. Derive an expression for mass transfer in leaching operation.	05
Q.3B	Explain with sketch the interpolation techniques of drawing a tie line through any point on the equilibrium curve.	05
Q.4A	Define the terms: (a) Bound Moisture (b) Drift Eliminators (c) Louvers (d) Fill in cooling tower	05
Q.4B	Explain liquid-liquid extraction with some industrial example? On what basis Type-I and Type-II ternary systems are classified.	05
Q.5A	Two mixtures R and E, which contain both the three components A, B and C, have to mix in the ratio 1:2. This ternary system has no miscibility gap so that all compounds are completely soluble each other. The mixture R has a composition of $x_{A,R} = 0.7$ and $x_{B,R} = 0.2$; the mixture E exists of $x_{A,E} = 0.2, x_{B,E} = 0.4$. Determine the mixing point $x_{C,M}$.	05
Q.5B	Define absolute humidity, relative humidity, humid volume, humid heat, percentage humidity and dew point. Also relate percentage humidity with relative humidity.	05
Q.6A	Explain the drying rate curve. Derive an expression to determine the drying time from the drying rate data.	05
Q.6B	It is necessary to dry a batch of 160kg of a wet material from 30% to 5% moisture content, under constant rate and falling rate period. The falling rate is assumed to be linear. Calculate the total drying time considering an available drying surface of 1m ² /40kg of dry solid. A constant drying flux of 3×10^{-4} kg/m ² is given: X_C = critical moisture content = $\frac{0.2 \text{ kg moisture}}{\text{kg solid}}$ X^* = equilibrium moisture content = 0.05 OR	05
Q.6B	In a vessel at 101.3 kN/m ² and 300 K, the percentage relative humidity of the water vapour in the air is 50. If the partial pressure of water vapour when air is saturated with vapour at 300 K is 3.6 kN/m ² , Calculate: (a) The partial pressure of water vapour in the vessel	05

	(b) The specific volume of the air and water vapour (c) The humidity of the air and humid volume (d) The percentage humidity	
Q.7A	Determine the height of the cooling tower.	05
Q.7B	1000 kg of an aqueous solution containing 35 mass% trimethyl amine (TMA) and 65% water is to be extracted using benzene as the solvent. A three stage cross current extraction scheme is suggested. The amounts of solvent (98% benzene, 2%TMA) to be used in successive stages are 815 kg, 950 kg and 2625 kg. The solute concentration in extract and Raffinate phases in stage 1, stage 2 and stage 3 are 0.24 and 0.166, 0.15 and 0.105, 0.0596 and 0.0506 respectively. Determine the fraction of the solute removed if the stages are ideal.	10
	OR	
Q.7B	One thousand kilograms of an aqueous solution containing 50% acetone is contacted with 800 kg of chlorobenzene containing 0.5 mass% acetone in a mixer-settler unit, followed by separation of the extract and raffinate phases. The solute concentration in extract and Raffinate phases are 0.302 and 0.236. Determine the fraction of acetone extracted.	10
Q.8	Explain McCabe-smith algebraic method of determination of ideal washing stages.	10
Q.9	Waxed paper contains 25 wt% wax and 75 wt% cellulose. The amount of paper to be processed is 4 ton/day. The wax must be removed so that the processed paper contains only 0.2 kg wax/100 kg cellulose. Kerosene feed used to dissolve the wax contains 0.05kg wax/100 kg pure (non-wax) kerosene. It has been found experimentally that the cellulose fibers of the processed paper carry 2 kg of kerosene/kg of paper free of kerosene and wax. Wax composition in the used solvent should be 5kg per 100kg of pure kerosene. Calculate the needed number of ideal stages.	15
	OR	
Q.9	The mixture of air and water-vapour has a dry bulb temperature of 60°C and an absolute humidity of 0.03 kg-water vapour/kg-dry air. The system pressure is at 1 atm absolute. Evaluate: (a) Saturation absolute humidity (b) Relative humidity (c) Dew point temperature (d) Humid Volume (e) Humid heat (f) Enthalpy (g) Heat required to heat 1.2 m ³ of this mixture to 120°C (h) Adiabatic saturation temperature (i) wet bulb temperature	15
	[Note: Psychrometric chart is attached at the end of the paper. Attached the chart with your answer sheet after solving the paper]	



Psychrometric chart for the air-water system at 1 atm total pressure.