Ref. No. : Ex/PHARM/T/424/2019

Name of the Examinations: B. PHARMACY FOURTH YEAR SECOND SEMESTER - 2019

Subject
PHARMACEUTICALENGINEERING -II **Time :** 3 hr **Full Marks :** 100

(Answer any five questions taking at least two questions from each group.)

GROUP A

Q1.A distillation column operating at 1 atm is to be designed for separating an ethanol-water mixture. The feed is 20 mole% ethanol and the feed flow rate is 1000 kg-mole/hr of **saturated liquid(q=1).** A distillate composition of 80 mole% ethanol and a bottoms composition of 2 mole% ethanol are desired. The reflux ratio is 5/3.Relative volatility of Ethanol (78.4°C), α_{EW} is 2.29.

(i) Determine distillate and bottoms flow rates in kg-mole/hr. (ii) Determine the total number of ideal stages including reboiler required to achieve separation, and number of plates to be installed in rectifying and stripping section. To which plate must the feed be introduced? Calculate N_{min}. Calculate efficiency of column if actual number of plates is 20. Calculate minimum reflux. (iii) Draw a neat figure of the ideal column as per this problem, with appropriate labels.

Equilibrium data for ethanol-water system at 1 atm pressure

x	0	0.019	0.0966	0.2337	0.5079	0.6763	0.8943	0.95
y	0	0.17	0.4375	0.5445	0.6564	0.7585	0.8943	0.95

Marks 20

Q2.(a) Write on flash distillation operation with a neat diagram of its set up and related equations.

(b)Draw a boiling point diagram of benzene-toluene with the following data:

Temp.°C	Mol fraction of benzene in liquid	Mol fraction of benzene in vapor
80	1	1
85	0.78	0.9
90	0.581	0.777
95	0.411	0.632
100	0.258	0.456
105	0.13	0.26
110.6	0	0

A mixture of 50 mole percent benzene and toluene is subjected to flash distillation at a separator pressure of 1 atmosphere . The incoming liquid is heated to a temperature that causes 40 percent of the feed to flash. The temperature in the separator is assumed to be 95 °C (relative volatility is 2.45) and boiling point of the feed is 92 °C.

(a) What are the compositions of the vapor and liquid leaving the flash chamber?(b) What is the required feed temperature?

Data:for benzene λ=7360 cal/gm mole, Cp=33 cal/mol.°C;

for toluene λ=7960 cal/gm mole, Cp=40 cal/mol.°C.

Marks 10+10

Q3.(a)Derive the expressions for liquid- liquid extraction by Cross current and Counter current mode of operation by mass balance, and show the related graphical figures required to solve extraction problems using these expressions.

(b) 1 kg aqueous solution of pyridine containing mass fraction (0.24) of pyridine is to be purified by extracting with a solvent (chlorobenzene, 300 gm) in a cross current extraction process at 25°C. Water and solvent are insoluble with other. Feed is contacted **twice** with same quantity of fresh solvent. Determine **amount of pyridine** extracted in each step ,and **%** of total amount extracted after two stages and verify your result from the raffinate composition.

Equilibrium data:Y' is kg of pyridine per kg of chlorobenzene , x'is is kg of pyridine per kg of water

(Y',X')- 10^{-2} *[(7, 3.25), (15.5 , 6.75), (21.5, 10), (26.5, 15), (30 ,20), (40, 32.6)]

Marks 10+10

Q4. Write short notes on any **four** of the following.

(a)Factors controlling leaching operation,(b) criterion for the selection of ideal solvents,

(c)plate efficiency,(d) minimum reflux ratio, and minimum number of plates,(e)arrangement of down comer in rectification column,(f)bubble cap column.

Marks 4x5

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B. PHARMACEUTICAL TECHNOLOGY FOURTH YEAR SECOND SEMESTER -2019

PHARMACEUTICAL ENGINEERING-II TIME: 3 h FULL MARKS: 100

ANSWER ANY FIVE QUESTIONS TAKING ATLEAST TWO FROM EACH GROUP

GROUP-B

(Use graph paper and psychometric chart as required)

1.

a. A continuous counter current dryer is used to dry 500 kg dry solid/h containing 0.04 kg total moisture/kg dry solid to a value of 0.0017 kg total moisture/kg dry solid. The granular solid enters at 20^0C and leaves at 70^0C. The heating medium is air which enters at 90^0C, has a humidity of 0.016 kg H_2O/kg dry air and leaves at 32.8^0C. Calculate the air flowrate and the outlet humidity, assuming the heat losses from the dryer to be 9200 KJ/h.

Given: The constant heat capacity of the dry solid = 1.465 KJ/kg -k

The value of latent heat of water at 0^0C = 2600 KJ/kg [8]

b. It is desired to absorb 90% of acetone by water from a mixture of acetone and nitrogen containing 2% of the component in a counter current tray tower. Total gas input is 35 kmol/hr and water enters the tower at a rate of 85 kmol/hr. The tower operates at 30^0C and 1 atm. The equilibrium relation is Y=2.2* X. Determine the number of ideal stages necessary for the separation using (a) graphical method as well as (b) Kremser analysis method. [10]

c. Derive Lambert's, Beer's and Beer-Lambert's law. [02]

2.

a. Two airstreams are mixed steadily. The specific humidity, the relative humidity, the dry-bulb temperature, and the volume flow rate of the mixture are to be determined. [10]

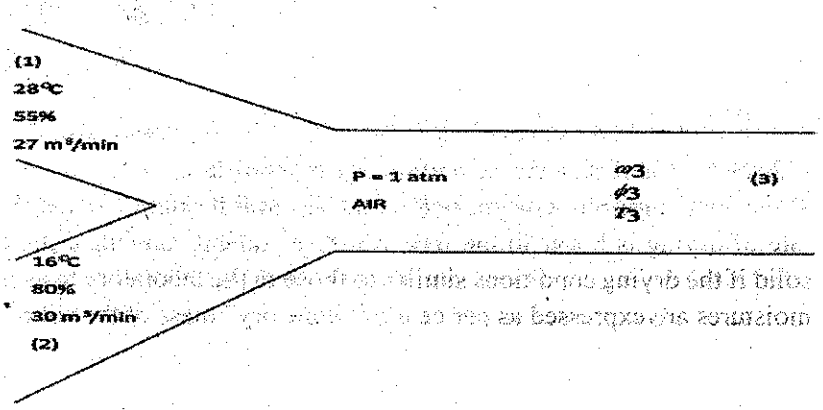

Figure: 1

b. A test tube, 2 cm in diameter and 20 cm long, has 0.5 gm camphor ($C_{10}H_{16}O$) in it. How long will it take for camphor to disappear? The pressure is atmospheric and temperature is 20^0C. The sublimation pressure of camphor at this temperature is 100 mm Hg; diffusivity of camphor can be estimated by using Fuller's Equation:

$$D_{AB}=\frac{1.0133\times10^{-7}T^{1.75}}{P[(\sum v)_A^{1/3}+(\sum v)_B^{1/3}]}\left[\frac{1}{M_A}+\frac{1}{M_B}\right]^{1/2} m^2/s$$; where T in K; P in bar, M_A, M_B are molecular weights of A and B, respectively and $\sum v_A=200\,m/s$; $\sum v_B=18.1\,m/s$. [5]

c. Derive the expression for drying time. Write short note in Tray dryer, Rotary dryer. [5]

3.

a. Solute *A* is to be absorbed from a binary mixture containing 8 % of *A* with solvent *B* in a packed tower. Based on flooding calculation, a tower diameter of 2 m is selected. Total gas flow rate is 70 kmol/h. The exit gas must not contain 0.4% of solute *A*. Solute free liquid *B* enters from the top of the tower at 30 kmol/h. The gas phase and liquid phase mass transfer coefficients based on mole ratio unit are: k_X =2.05 kmol/m^{2}h (ΔX) and k_Y =2 kmol/m^{2}h (ΔY). The equilibrium line Equation is Y=0.8X. Specific interfacial area of gas-liquid contact ($\bar{a}$) is 75 m^2/m^3. (i) Calculate packing height required for the desired separation. (ii) For 98.5% solute *A* removal, what % increase in packed height is needed? (iii) Determine slopes of operating line in each case. [10]

b. [5]

A simple U-tube can be used to determine the specific gravity "s" of liquids which are denser than water by the arrangement shown below. Derive an expression for "s" in terms of h_1, h_2, h_3 and h_4.

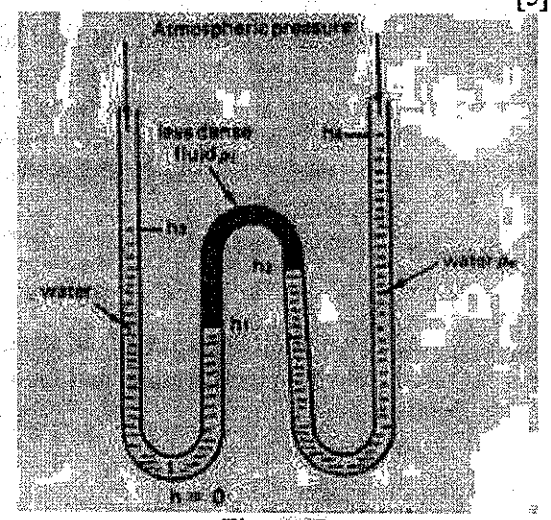

Figure: 2

c. A wet solid of 30% moisture is to be dried to 0.6% moisture in a tray drier. A laboratory test shows that it requires 12 h to reduce the moisture content of the same solid to 3%. The critical moisture content is 8% and the equilibrium moisture is 0.2%. The falling rate of drying is linear in the free moisture content. Calculate the drying time of the solid if the drying conditions similar to those in the laboratory tests are maintained. All moistures are expressed as per cent of "bone dry" mass of the solid.

[5]

4.

a. MeOH (A) is separated from aqueous solution by distillation. At a section of column, vapor phase contains 0.8 mole fraction MeOH and liquid phase has 0.55 mole fraction. Temperature of the section is 80^0C and total pressure is 1 atm. throughout 1 mm thick vapor film. If molar latent heat of vaporization of MeOH is 8585.5 K Cal/K-mol and that of water (B) is 10040 K Cal/K-mol at the given temperature. Calculate MeOH and water vapor flux. *Given:* If mole fraction of MeOH in liquid is 0.55, equilibrium vapor will be 0.795. Vapor phase diffusivity of MeOH, $D_{AB}=1.696\times10^{-5}$ m^2/s.

b. Hydrochloric acid (A) diffuses through a thin film of water (B) 5.0 mm thick at 300 K. The concentration of HCl at point 1 on one boundary of the film is 15 wt.% and on the other boundary, at point 2 is 5 wt.%. The diffusivity of HCl in water is 2.59×10^{-9} m^2/s. Calculate the flux of HCl considering water to be stagnant. Density of the solutions at points 1 and 2 are 1050.73 kg/m3 and 1030.59 kg/m^3 respectively.

c. A sharp-edge circular orifice is to be used to measure the flow rate of water at 20°C (ρ=1000 kg/m^3, μ= 1 mPa-s.) in a pipeline with an internal diameter of 250 mm. The orifice diameter is 50 mm. The reading of a mercury (ρ_M = 13600 kg/m^3) manometer at the throat tap position is 242 mm. Calculate the flow rate in l/s.

d. Write short note on the followings
   i. Psychrometers
   ii. Gas Chromatography
   iii. Wet Gas Meter.

[8+6+3+3=20]

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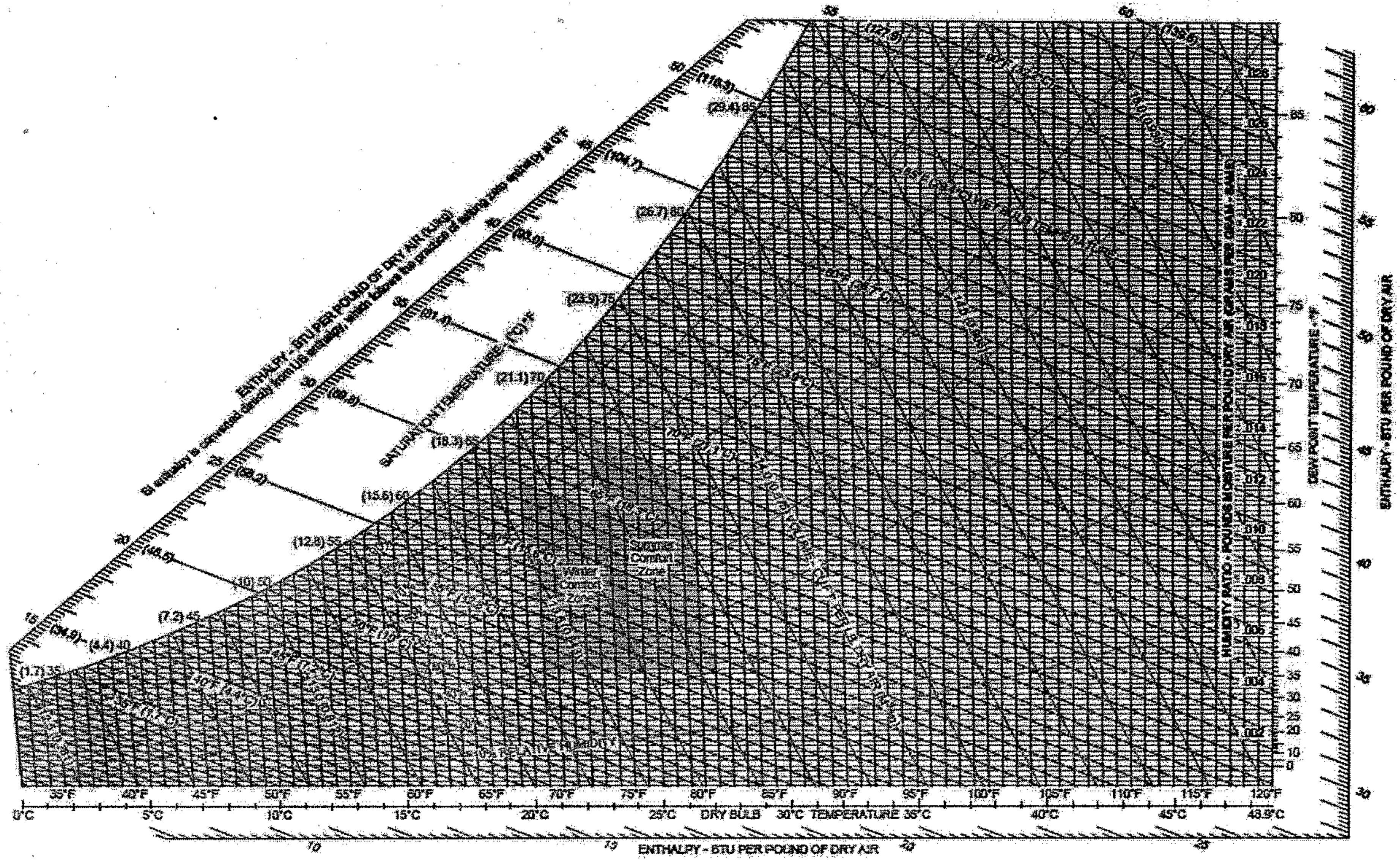

ENTHALPY - BTU PER POUND OF DRY AIR (kJ/kg)
SI enthalpy is converted directly from I-P enthalpy, which follows the practice of setting zero enthalpy at 0°F
SATURATION TEMPERATURE - (°C) °F
Summer Comfort Zone
Winter Comfort Zone
DRY BULB TEMPERATURE
ENTHALPY - BTU PER POUND OF DRY AIR
DEW POINT TEMPERATURE - °F
HUMIDITY RATIO - POUNDS MOISTURE PER POUND DRY AIR
0°C
5°C
10°C
15°C
20°C
25°C
30°C
35°C
40°C
45°C
48.9°C
35°F
40°F
45°F
50°F
55°F
60°F
65°F
70°F
75°F
80°F
85°F
90°F
95°F
100°F
105°F
110°F
115°F
120°F
(1.7) 35
(4.4) 40
(7.2) 45
(10) 50
(12.8) 55
(15.6) 60
(18.3) 65
(21.1) 70
(23.9) 75
(26.7) 80
(29.4) 85