

Printed Pages : 4



ECH-301

(Following Paper ID and Roll No. to be filled in your Answer Book)

PAPER ID : 151304

Roll No.

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B. Tech.

(SEM. III) (ODD SEM.) THEORY
EXAMINATION, 2014-15
PROCESS CALCULATIONS

Time : 3 Hours]

[Total Marks : 100

Note: Attempt **All** questions.

1. Do any **two** parts of the following : **10x2=20**
- (a) Explain effect of temperature on vapor pressure with the help of thermodynamic relationship. The following table gives the vapor pressures of pure hexane and pure heptane .

Temperature °C	Vapor Pressure, mm Hg	
	Hexane	Heptane
69	760	295
70	780	302
75	915	348
80	1060	426
85	1225	498
90	1405	588
95	1577	675
99.2	1765	760

Assuming that Raoult's law is valid, use the above data to calculate for each of the above temperatures the mole percent x of hexane in the liquid and the mole percent y of hexane in the vapor, at a total pressure of 760 mm Hg.

- (b) Define Conversion, Selectivity, Yield, Limiting and Excess reactant and Degree of completion.
- (c) What is the difference between complete and incomplete combustion, Propane is burned with excess air to ensure complete combustion. If 55 kg of CO_2 and 15 kg of CO are obtained when propane is completely burned with 500 kg of air determine the mass of propane burnt, percent excess air and composition of flue gas.

2. Do any **two** parts : **10x2=20**

- (a) What are the various terms involved in Humidification and dehumidification process explain any six of them.
- (b) One cubic meter of a gas at STP is to be dried from a dew point of 300 K to a dew point of 285 K, How much water must be removed ? The vapor pressure of water is 1.4 kPa at 285 K and 3.56 kPa at 300 K.
- (c) It is proposed to recover acetone by evaporation in a stream of nitrogen. The nitrogen enters the evaporator at a temperature of 30°C containing acetone such that its dew point is 10°C and leaves at 25°C with dew point 20°C , the barometric pressure is constant 750 mm Hg.

Calculate vapor concentrations at inlet and outlet in moles of vapor per mole of vapor free gas also calculate the weight of acetone evaporated and the volume of gases leaving the evaporator per 100 liters entering.

Vapor pressure of acetone

116 mm Hg at 10°C

185 mm Hg at 20°C

3. Do any **two** parts : **10x2=20**
- (a) Two liquids A and B are only partially miscible. At a certain temperature 41 kg of A and 59 kg of B are mixed well and mixture is allowed to settle. The mixture separates into two immiscible phases, one rich in A and the other rich in B. The A rich phase analyses 90% of A and B rich phase analyses 80% B. What are weights of A rich and B rich phases ?
- (b) In Synthesis of methanol fresh feed containing 32% CO, 64 % H₂ and 4 % inert (by volume) is mixed with recycle feed. Mixed feed entering the reactor results in 20% per pass conversion of CO. The product stream from reactor is fed to condenser where the entire methanol formed gets condensed and the gasses from condenser are recycled. In order to prevent build up of inert in recycle loop a small portion of the gases leaving the condenser is continually purged. If mixed feed contains 13 mole % inert calculate recycle and purge ratio.
- (c) Explain Distillation and Absorption with reference to material balance and explain their industrial importance.

4. Do any **two** parts : **10x2=20**
- (a) Calculate the theoretical flame temperature of gas having 20% CO and 80% N₂ when burnt with 150% excess air. Both air and gas being at 25°C
- Data:
- Heat of formation at 25°C
 CO₂ = -94052 cal/g mole
 CO = -26,412 cal/g mole
- C_{pm} values for the above temperature range
 CO₂=12.1, O₂=7.9, N₂=7.55 cal/g mole K

- (b) One kg of water is heated from 250K to 400K at one standard atmospheric pressure. How much heat is required for this ? The mean heat capacity of ice between 250K to 273 K is 2.037 kJ/kg K, the mean heat capacity of water between 273 and 373 K is 75.726 kJ/Kmol K and the heat capacity of water vapor (kJ/kmol K) is
- $$C_p = 30.475 + 9.652 \times 10^{-3} T + 1.189 \times 10^{-6} T^2$$
- where T is in K. The latent heat of fusion and vaporization of water are respectively 6012 kJ/kmol and 40608 kJ/kmol
- (c) What is the importance of material and energy balance in chemical plants justify your answer with the help of examples.
5. Do any **two** parts : **10x2=20**
- (a) Explain a process where simultaneous material and energy balances are used.
- (b) How degree of freedom analysis is helpful in solving the problems of chemical engineering, explain with the help of suitable examples.
- (c) A storage tank contains 10000 kg of a solution containing 5% acetic acid by weight. A fresh feed of 500 kg/min of pure water is entering the tank and dilutes the solution in the tank. The mixture is stirred well and the product leaves the tank at a rate of 500 kg/min. At what instant of the time the acid concentration in the tank will drop to 1% acetic acid by weight. After one hour of operation what will be concentration in the tank.
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