

Course: B. Tech in Chemical /Petrochemical Engineering

Sem: III

Subject Name: Chemical Process Calculation

Subject Code: BTCHC 302

Max Marks: 60

Date: 03/12/2018

Duration: 3 Hr.

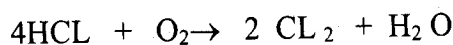
**Instructions to the Students:**

1. Solve ANY FIVE questions out of the following.
2. The level question/expected answer as per OBE or the Course Outcome (CO) on which the question is based is mentioned in ( ) in front of the question.
3. Use of non-programmable scientific calculators is allowed.
4. Assume suitable data wherever necessary and mention it clearly.

	(Level/CO)	Marks
<b>Q. 1 Solve the following.</b>		
A) A mixture is 10 mole% ethyl alcohol, 75 mole% ethyl acetate (C <sub>4</sub> H <sub>8</sub> O <sub>2</sub> ) and 15 mole% acetic acid. Calculate the weight fraction of each of the compound. What is the average molecular mass of the mixture. What would be the weight (Kg) of a sample containing 25 km ol of ethyl acetate.	Apply	04
B) A label has come off a cylinder of a gas in your laboratory. You know only that one species of gas is contained in the cylinder, but you don't know whether it is hydrogen, oxygen or nitrogen. To find out , you evacuate a 5 liter flask ,seal it and weigh it, and then let the gas from he cylinder flow into it until gauge pressure equals 1.0 atm. The flask is reweighed and the mass of added gas is found to be 13 gm. Room temperature is 27 <sup>o</sup> C and barometric pressure is 1 atm. What is that gas?	Analyze	04
C) A sample of caustic soda flakes contains 74.6% Na <sub>2</sub> O (by mass). Find the purity of the flakes.	Understand	04
<b>Q.2 Solve Any Two of the following.</b>		
A) The waste acid from nitrating plant contains 30% H <sub>2</sub> SO <sub>4</sub> , 35% HNO <sub>3</sub> and 35% water. The acid is to be concentrated to 39% H <sub>2</sub> SO <sub>4</sub> , 42% HNO <sub>3</sub> by addition of concentrated H <sub>2</sub> SO <sub>4</sub> containing 98% H <sub>2</sub> SO <sub>4</sub> and concentrated HNO <sub>3</sub> containing 72% HNO <sub>3</sub> (by weight). Calculate the quantities of three acid to be mixed to get 1000 kg of desired mixed acid.	Apply	06
B) Straw berries contain 15% solids and 85% water. To make strawberry jam, crushed strawberries and sugar are mixed in a 45 : 55 ratio and the mixture is heated to evaporate water until residue contain one tired water by mass. Calculate how many kg of strawberries are needed to make one kg of jam. (All percentage and ratio are by weight.)	Apply	06
C) An evaporator is to produce 1300 kg/hr of dry common salt from a feed solution containing 20% NaCl .The salt removed carries 20% of its weight as saturated brine(The saturated brine contains 27% NaCl) Calculate the feed rate to the evaporator in kg/hr.	Apply	06
<b>Q.3 Solve the following.</b>		
A) The oxidation of ethylene to produce ethylene oxide proceeds according to the equation	Understand	06
$2\text{C}_2\text{H}_4 + \text{O}_2 \longrightarrow 2\text{C}_2\text{H}_4\text{O}$		

The feed to the reactor contains 100 kmol C<sub>2</sub>H<sub>4</sub> and 100 kmol O<sub>2</sub>. i) Which is the limiting reactant? ii) What is the percentage excess of other reactant? iii) If the reaction proceeds to completion, how much of the excess reactant will be left; how much C<sub>2</sub>H<sub>4</sub>O will be formed and what is the extent of reaction?

- B) In a Deacon process for manufacturing chlorine, hydrochloric acid gas is oxidized with air. The reaction taking place is: Apply 06



If the air is used in excess of 30% of that theoretically required, and if the oxidation is 80% complete, calculate the composition by volume of dry gases leaving the reaction chamber.

**Q.4 Solve Any Two of the following.**

- A) The dry bulb temperature and the dew point of an ambient air were found to be 29°C and 18°C respectively. The barometer reads 750 mm Hg pressure. Understand 06  
Compute

- i) Absolute humidity ii) % Relative humidity iii) % Humidity

Data V.P. of water at 18°C = 20 mmHg

V.P. of water at 29°C = 42 mmHg

- B) Fresh orange juice contain 12 mass-% solid and balance water and concentrated orange juice contain 42% solids. Initially a single stage evaporation process was used for concentration, but volatile constituent of juice escaped with water, resulting in flat taste. The present process overcomes this problem by bypassing the evaporator with a fraction of fresh juice that enters the evaporator is concentrated to 58% solids and the product is mixed with bypass fresh juice to achieve the desired final concentration of solids. Calculate the amount of concentrated juice produced per 100 kg of fresh juice fed to the process and fraction of feed that bypasses the evaporator. Apply 06
- C) With neat flow diagram, explain recycle, bypass and purging operations in process industries and their importance. Remember 06

**Q.5 Solve the following**

- A) Tin is melted in an open pan using jacket. The jacket is fed with eutectic mixture of diphenyl-diphenyl oxide at 1.73 kgf/cm<sup>2</sup>a. Tin is fed to the pan at 30°C. Calculate the quantity of eutectic mixture condensed per 100 kg of tin melted at its melting point temperature. Assume no subcooling of vapors. Apply 06

Data for tin: Molecular Weight - 118.7

Melting point --- 231.8°C, Latent heat of fusion - 1720 kcal/kmol

Specific heat of solid tin

$$C = 5.05 + 0.0048 T \quad (\text{kcal/kmol.K})$$

Where T is in degree Kelvin.

Data for Diphenyl- Diphenyloxide mixture at 1.73 kgf/cm<sup>2</sup> a

Saturation Temp. °C	Enthalpy(kcal/kg)		
	Sensible	Latent	Total
280	120.5	66.5	187.00

- B) Calculate the quantity of heat to be added to raise the temperature of 5 kmol of CO<sub>2</sub> from 25 to 500°C. Heat capacity is given by the following equation. Understand 06

$$C_p = 19.774 + 73.375 \times 10^{-3} T - 56.02 \times 10^{-6} T^2 + 17.155 \times 10^{-9} T^3$$