DR. BABASAHEB AMBEDKAR TECHNOLOGICAL UNIVERSITY, LONERE

End Semester Examination – Winter 2018

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
Q. 1	**Solve the following.**		
A)	A mixture is 10 mole% ethyl alcohol, 75 mole% ethyl acetate ($C_4H_8O_2$) 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 27^0 C and barometric pressure is 1 atm. What is that gas?	**Analyze**	**04**
C)	A sample of caustic soda flakes contains74.6% Na_2O (by mass). Find the purity of the flakes.	**Understand**	**04**
Q.2	**Solve Any Two of the following.**		
A)	The waste acid from nitrating plant contains 30% H_2SO_4,35% $HNO_3$and 35% water. The acid is to be concentrated to 39% H_2SO_4, 42% HNO_3 by addition of concentrated H_2SO_4 containing 98% H_2SO_4 and concentrated HNO_3 containing 72% HNO_3 (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**
Q. 3	**Solve the following.**		
A)	The oxidation of ethylene to produce ethylene oxide proceeds according to the equation $2C_2H_4 + O_2 \longrightarrow 2\ C_2H_4O$	**Understand**	**06**

The feed to the reactor contains 100 kmol C_2H_4 and 100 kmol O_2. i)Which is the limiting reactant ? ii) What is the percentage excessof other reactant? iii) If the reaction proceeds to completion , howmuch of the excess reactant will be left; howmuch C_2H_4O 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**

$$4HCL + O_2 \rightarrow 2\ CL_2 + H_2O$$

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 29^0C and 18^0C respectively .The barometer reads 750 mm Hg pressure . Compute **Understand** **06**

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

Data V.P. of water at 18^0C = 20 mmHg

V.P. of water at 29^0C = 42 mm Hg

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^2a. Tin is fed to the pan at 30^0C.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 --- 231.8^0C ,Latent heat of fusion –1720 kcal/kmol

Specific heat of solid tin

$C = 5.05 + 0.0048\ T$ (kcal/kmol.K)

Where T is in degree Kelvin.

Data for Diphenyl- Diphenyloxide mixture at1.73 kgf/cm^2 a

Saturation Temp. ^0C	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_2 from 25 to 500 ^0C. Heat capacity is given by the following equation. **Understand** **06**

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