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B.E. / B.TECH. DEGREE EXAMINATIONS, DEC 2019

Fourth Semester

CH16401 – CHEMICAL PROCESS CALCULATIONS*(Chemical Engineering)***(Regulation 2016)****Time: Three Hours****Maximum : 100 Marks**Answer **ALL** questions**PART A - (10 X 2 = 20 Marks)**

	CO	RBT
1. Define molality, normality, and molarity?	1	R
2. State the Avogadro's principle?	1	R
3. With block diagram distinguish between recycle and by pass.	3	AN
4. Find the limiting reactant, If 4.95 g of Ethylene (C ₂ H ₄) is combusted with 3.25 g of Oxygen.	3	AN
5. Define Henry's law and state its application.	2	R
6. Differentiate between proximate and ultimate analysis.	3	AN
7. What is standard heat of reaction?	4	R
8. 20 kg of water is heated from room temperature (30°C) to produce steam of temperature 100°C. The latent heat of vaporization of water at atmospheric pressure is 2259 kJ/kg. Calculate the sensible heat and the total heat supplied during this operation.	4	AP
9. State few applications of mathematical modeling and numerical simulation in Chemical Engineering.	4	AP
10. Write the material balance for unsteady state operation.	4	AP

PART B - (5 X16 = 80 Marks)

11. (a) (i) A solution of sodium chloride in H₂O contains 25% NaCl (by mass) at 323 K. The density of the solution is 1.135 kg/litre. Find molarity, normality and molality of the solution **(10)** **1** **U**
- (ii) Air is flowing through a duct under a draft of 4.0cm of H₂O. The barometer indicates that the atmospheric pressure is 730 mm Hg. What is the absolute pressure of the gas in inches of mercury? **(6)** **1** **AP**

(OR)

- (b) (i) Iron metal weighs 500 lb and occupies a volume of 29.25 liters. Find the density in kg/m^3 . (6) 1 U
- (ii) 130 kg of gas has the following composition: 40% N_2 , 30% CO_2 , and 30% CH_4 in a tank. What is the average molecular weight of the gas? What is the weight (mass) fraction of each of the components in the mixture? (10) 1 AN
12. (a) (i) SO_2 is produced by the reaction between Copper and Sulphuric acid. How much Copper must be used to get 10 kg of SO_2 . (8) 2 AP
- (ii) A crystallizer is fed with 15000 kg/hr of a solution containing 10% NaCl, 15% NaOH and rest water. In the operation, water is evaporated and NaCl is precipitated as crystals. The thick liquor leaving the evaporator contains 45% NaOH, 2% NaCl and rest water. Calculate (8) 2 AP
- (a) kg/hr of Water Evaporated.
- (b) kg/hr of Salt Precipitated.
- (c) kg/hr Thick liquor obtained.
- (OR)
- (b) (i) A continuous fractionating column is to be designed to separate 10000 kg/hr of a mixture of 50 mol% toluene to give an overhead product containing 98 mol% benzene and a bottom product of 97 mol% toluene. Compute the overhead and bottom products obtained per hour. (10) 2 AP
- (ii) A water soaked fabric is dried from 44% moisture to final moisture of 9%. Calculate the weight of water removed per 200 kg of dried fabric. (6) 2 AP
13. (a) (i) In an ultimate analysis the following are estimated C=65.93%, N = 1.30% available H = 3.5%. Combined H_2O = 6.31% free moisture = 4.38%. Calculate the % of ash, If 2 gram of coal is fired how much ash is expected. (12) 3 AN
- (ii) How are NCV and GCV related? Explain. (4) 3 U

(OR)

- (b) Chimney gas has the following composition: CO₂ -9.5%:CO-0.2%: O₂-9.6% and N₂-80.7%. Using ideal gas law, calculate (16) 3 AP
- Its weight percentage
 - Volume occupied by 0.5kg of gas at 30°C and 760 mmHg
 - Density of the gas in kg/m³ at condition of (ii)
 - Specific gravity of the gas mixture
(Density of air may be taken as 1.3 kg/m³)
14. (a) The molal heat capacity of CO is given by (16) 4 AP
- $$C_p = 26.586 + 7.582 \times 10^{-3}T - 1.12 \times 10^{-6} T^2$$
- where C_p is in kJ/kmol K and T is in K.
- Calculate the mean molal heat capacity in the temperature range of 500-1000 K.
 - CO enters a heat exchanger at a rate of 500m³ per hour at STP. Calculate the heat to be supplied to the gas to raise its temperature from 500 to 1000 K.
 - CO is to be heated from 500 to 1500 K. What percent error is expected if the heat requirement is calculated using the mean heat capacity value determined in part (1)?
- (OR)**
- (b) Calculate the theoretical flame temperature of a gas having 25% CO and 75% N₂ when burnt with 100% excess air. Both air and gas being at 25°C. Data: Heat of formation of CO₂= -94052 cal/gmole & that of CO= -26412 cal/gmole at 25°C; C_{p_m} of CO₂=12.1, O₂=7.9, N₂=7.55 Cal/gmole K. (16) 4 AP
15. (a) A tank contains 10 litre of a salt solution at a concentration of 2 g/litre another salt solution enters the tank at a rate of 1.5 litres/min at a salt concentration of 1 g/litre. The contents are stirred well and the mixture leaves the tank at a rate of 1.0 litre/min. (16) 4 AP
- Estimate (a) the time at which the concentration in the tank will be 1.6 g/litre and (b) the contents in the tank will be 18 litres.
- (OR)**
- (b) Discuss the uses and application of process simulators in process industry. (16) 4 AP