B.E./B.TECH. Degree Examination, December 2020

Fourth Semester

CH16401 – Chemical Process Calculations

(Regulation 2016)

Time: Three hours Maximum : 80 Marks

Answer **ALL** questions

PART A - (8 X 2 = 16 marks)

1. For producing 6 mole of H_2O, how many Kgs of Glucose is required?
   a) 180 b) 360 c) 540 d) 720
2. A Stream that leaves a process unit that is the downstream and is returned to the same unit is called
   a) Recycle b) Purge c) Bypass d) None of the mentioned
3. Incorrect equation for an ideal is
   a) PV = nRT b) Pv = RT c) PM = ρRT d) None of the mentioned
4. A process in which no heat transfer takes place (Q=0) is
   a) Isobaric process b) Adiabatic process c) Isothermal process
   d) None of the mentioned
5. Sketch a distillation column with input and output streams.
6. Carbon and O_2 are present in the mole ratio of 4:3 with one mole of C and 0.75 moles of O_2, 0.5 mole of CO2 produced. Identify the excess and limiting reactant.
7. Differentiate proximate and ultimate analysis.
8. "The molecular heat capacity of a solid compound is the sum of the atomic heat capacities of the elements composing it" which rule is that, give example.

PART B - (4 X16 = 64 marks)

9. (a) (i) A natural gas has the following composition by volume Methane -83%, Ethane – 12% and Nitrogen – 5%. Calculate the composition in (1) Mole% (2) Weight % (3) Average molecular weight. **(8)**

   (ii) Calculate absolute pressure of the gas in inches of mercury when air is flowing through a duct under a draft of 7.0cm of H_2O. The barometer indicates that the atmospheric pressure is 750 mm Hg. **(8)**

   (OR)

   (b) Explain any four process variables and its properties. **(16)**

10. (a) (i) The feed to a fractionating column analyses by weight 32% benzene and 68% toluene. The analyses of the distillate shows 52 weight % benzene and 5% product. Calculate the amount of distillate and bottom product per 1500 kg of feed per hour. Also calculate the percent recovery of benzene. **(8)**

    (ii) A solution of $NaNO_3$ in H_2O at a temp of 40°C contains 59% $NaNO_3$ by weight. Calculate

    (i) the weight of $NaNO_3$ that may be crystallized from 1000 kg of solution by reducing the temperature at 10°C. The solubility data at 10°C is 48.5% by weight & at 40°C is 50.4% by weight. **(8)**

    (ii) % Yield of Crystals

(OR)

(b) 200 kg of N_2 and 70kg of H_2 are brought together and allowed to react at 800K and 350 atm. It is found that there are 40 kmol of gases present at equilibrium. How many kilo moles of N_2, H_2 and NH_3 are present at equilibrium? Which is the limiting reactant? What is the % Excess? What is the degree of completion? What is the % conversion of hydrogen to NH_3? **(16)**

11. (a) Chimney gas has the following composition: CO_2 – 7.5%: CO- 1.2%: O_2-5.6% and N_2-75.7%. Using ideal gas law, calculate

i. Its weight percentage
ii. Volume occupied by 0.8kg of gas at 30°C and 760 mmHg
iii. Density of the gas in kg/m^3 at condition of (ii)
iv. Specific gravity of the gas mixture

(Density of air may be taken as 1.8 kg/m^3) **(16)**

(OR)

(b) Determine the flue gas analysis, air fuel ratio by weight , when a medium fuel oil with C – 82.9%, H_2 – 9.4%, S- 5.0%, O_2 – 0.9% and ash – 0.3% by weight is burned with 30% excess air. Assume complete combustion. **(16)**

12. (a) The molal heat capacity of CO is given by
$Cp = 24.586 + 9.582 \times 10^{-4}T - 3.12 \times 10^{-6} T^2$ Where Cp is in kJ/kmol K and T is in K.

1. Calculate the mean molal heat capacity in the temperature range of 500-1000 K.
2. CO enters a heat exchanger at a rate of 700 m^3 per hour at STP. Calculate the heat to be supplied to the gas to raise its temperature from 500 to 1000 K. **(16)**
3. 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 the gas containing 30% CO and 70% N_2. The gas is burnt with 100% excess air. Both air and gas are at the same conditions of 25^0C. Heats of formation of
CO_2 = -94000 and CO = -25400 cal/gm mole at 25^0C. The mean specific heat values are CO_2, O_2 and N_2 are 14.1, 6.0 and 7.5 cal/gm mole K respectively. **(16)**