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

Third Semester

CH18301 – CHEMICAL PROCESS CALCULATIONS*(Chemical Engineering)***(Regulation 2018)****Time: Three Hours****Maximum : 100 Marks**

Answer ALL questions

PART A - (10 X 2 = 20 Marks)

	CO	RBT
1. Convert the heat transfer coefficient of value 100 Btu/h.ft ² .°F into W/m ² °C	1	U
2. Calculate the volume of 15 kg of Chlorine at a pressure of 0.9 bar and 293 K.	1	U
3. Define limiting reactant and degree of completion.	2	R
4. Write any four significances of recycling.	2	R
5. Compare Relative humidity and percentage humidity.	3	U
6. If 'H' is the absolute humidity and 'T' is the dry bulb temperature of humid air, explain how to calculate the wet bulb temperature 'T _w ' and the dew point temperature 'T _D ' using humidity chart?	3	AP
7. Distinguish exothermic and endothermic reactions with example.	4	AP
8. Define theoretical flame temperature.	4	R
9. Give the use of Orsat apparatus.	5	R
10. List few process simulators used in chemical industries.	5	R

PART B - (5 X16 = 80 Marks)

11. (a) 1000 litres of mixture of H₂, N₂ and CO₂ at 150°C was found to have (16) 1 AP
the following ratio for the partial pressure of the gases:
P_{H₂}:P_{N₂}:P_{CO₂} is 1:4:3. If the total pressure is 2 atm absolute, calculate.
- Mole fraction of each of these gases
 - Weight per cent of each of these gases
 - Average molecular weight
 - Weight of CO₂ in kg.

(OR)

- (b) (i) Compare pressures given by the ideal gas and van der Waals equation for 1 mole of CO_2 occupying a volume of $(381 \times 10^{-6}) \text{ m}^3$ at 40°C . Given: $a = 0.3646$; $b = 4.28 \times 10^{-5}$ (10) 1 AP
- (ii) A compound's molecular weight is 103. Given Carbon = 81.5%, Hydrogen = 4.9% and $\text{N}_2 = 13.6\%$, by weight. Find its formula? (6) 1 AN
12. (a) (i) An evaporator system concentrating weak liquor from 10% to 50% solids, handles 200kg of solids per hour. If the same system is to concentrate a weak liquor from 5% to 40%. Find the capacity of the system in terms of solids that can be handled to be same assuming water evaporating capacity to be same in both cases. (10) 2 AP
- (ii) A cotton mill dries a water soaked fabric in a drier from 54% to 9% moisture. How many kg of water is removed by drying operation per 1200 kg of feed. (6) 2 AP

(OR)

- (b) 300 kg of N_2 and 75kg of H_2 are brought together and allowed to react at 823K and 300 atm. It is found that there are 38 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) 2 AN
- Given reaction: $\text{N}_2 + 3\text{H}_2 \text{ gives } 2\text{NH}_3$
13. (a) Air-water vapour sample has a DBT of 55°C with an absolute humidity of 0.03 Kg H_2O vapour/Kg dry air at 1 atm pressure. Calculate (i) Percentage humidity (ii) Absolute molal humidity (iii) Relative humidity (iv) Humid volume (v) Enthalpy (16) 3 AN

(OR)

- (b) A mixture of nitrogen – acetone vapour at 800 mmHg and 25°C has percentage saturation of 80%. Calculate (i) absolute humidity (ii) partial pressure of acetone (iii) absolute molal humidity and (16) 3 AN

(iv) volume percentage of acetone. Assume vapour pressure of acetone at 25°C as 190mmHg

14. (a) (i) Calculate the theoretical flame temperature of a gas having (10) 4 AN
20% CO and 80% N₂ when burnt with 150% excess air. Both
the reactants are at 25°C.

Data:

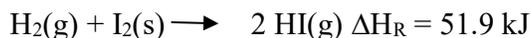
$$\Delta H_f^\circ \text{ of CO}_2 = -94052 \text{ cal/gmol}$$

$$\Delta H_f^\circ \text{ of CO} = -26412 \text{ cal/gmol}$$

Mean heat capacities in cal/gmol.°C are

$$\text{CO}_2 = 12, \text{O}_2 = 7.9, \text{N}_2 = 7.55$$

- (ii) Calculate the enthalpy of sublimation of Iodine from the (6) 4 AP
following data:



(OR)

- (b) Write short notes on the following: (16) 4 U
- I. Hess's law of heat summation
 - II. Kopp's rule
 - III. Heat of combustion and heat of formation
 - IV. Heat capacity

15. (a) A producer gas contains CO₂: 9.2%, C₂H₄: 0.4%, CO: 20.9%, H₂: (16) 5 AP
15.6%, CH₄: 1.9% and N₂: 52%, when it is burnt, the products of
combustion are found to contain CO₂:10.8%, CO: 0.4, O₂ :9.2%,
N₂: 79.6%. Calculate the following:

(a) m³ of air used per m³ of producer gas

(b) % excess air

(c) % N₂ that has come from producer gas.

(OR)

- (b) Discuss the uses and application of any two process simulators in (16) 5 U
chemical process industry.