Sample Test Paper – I

9197

Course Name :- Diploma in Chemical Engineering
Course code :- CH
Semester :- Third
Subject :- Stoichiometry
Duration :- 3hours **Marks : 80**

Instructions:

1) **All the questions are compulsory**
2) **Figures to the right indicate full marks**
3) **Assume suitable additional data if necessary**
4) **Non-programmable pocket calculator is allowed**

Q1. Attempt any eight. **Marks: 16**

a) State Charle's law and give its mathematical expression.
b) Give the value of R in S.I. and M.K.S. units.
c) State Vander waal's equation and give its application
d) What do you mean by overall balance and component balance?
e) Define excess component with suitable example.
f) Define latent heat of vaporization.
g) State Hess's law and give its application.
h) Define standard heat of formation.
i) Convert 0.5 Btu into calories.
j) Calculate the volume of 1 mole of air at STP

Q.2 Attempt any three. **Marks: 12**

a) A gas mixture contains 20% O_2, 30% CO_2 and 50 % N_2 (by mol). Calculate the average molecular weight of gas mixture.
b) A gas mixture contains 0.5 kg moles CH_4, 0.3 kg moles C_2H_6 and 2.6 kg moles N_2. Find out the density of gas mixture at 300^0K and 101.325 kpa.
c) A sample of gas having volume of 0.5 m^3 is compressed in such a manner so that pressure is increased by 60%. The operation is done for a fixed mass of gas at constant temperature. Calculate the final volume of gas.
d) For the reaction $CO+1/2\ O_2 \longrightarrow CO_2$, 100 kmoles of CO and 300 kmoles airs are fed. The product stream contains 80 kmoles CO_2. Calculate the % conversion of CO.

Q3. Attempt any two. **Marks: 12**

a) 1000 kg/hr of methanol water mixture containing 50% methanol is fed to a distillation tower. Distillate contains 90% methanol and residue contains 8% methanol (% are by weight). Calculate
   (i) kg/hr of distillate
   (ii) kg/hr of residue
   (iii)% recovery of methanol

b) The groundnut seeds containing 45% oil and 45% solids are fed to expeller, the cake coming out of expeller is found to contain 80% solids and 5% oil. Find the percentage recovery of oil.

c) It is desired to prepare 1000 kg of a solution containing 35% by weight of a substance A. Two solutions are available, one containing 10 weight % A and other containing 50 weight % A. How many Kgs of each solution will be required?

Q4. Attempt any two. **Marks: 16**

a) In production of chlorine gas by oxidation of hydrochloric acid gas, air is used 30% excess of that theoretically required. Based on 4 kmol HCL, calculate

(i) Weight ratio of air to HCl gas fed

(ii) If oxidation is 80% complete, find the composition of product stream on mol basis.

b) Pure sulphur is burnt in a sulphur burner with dry air. Oxygen is used 20% excess above that required for the complete combustion of sulphur to SO_3.The efficiency of burner is such that only 30% of the sulphur burns to SO_3 remainder goes to SO_2. Calculate

(i) The analysis of the resulting mixture in mol%.

(ii) The weight of gas per kg of sulphur burnt

c) A mixture of pure CO_2 and H_2 is passed over a nickel catalyst. The temperature of the catalyst bed is 588 k and the reactor pressure is 2 MPag. The analysis of the gases leaving the reactor showed CO_2 = 57%, H_2 = 41.1%, CH_4 = 1.68 and CO = 0.12% by volume on a dry basis. The reaction taking place are

$$CO_2 + 4H_2 \longrightarrow CH_4 + 2H_2O$$

$$CO_2 + H_2 \longrightarrow CO + H_2O$$

Find (i) The conversion of CO_2 per pass

(ii) The yield of CH_4 in terms of CO_2 reacted

(Iii) The composition of feed on volume basis.

Q5. Attempt any two. **Marks: 12**

a) Calculate the heat of formation of benzoic acid crystals ($C_7H_6O_2$) at 298 k using following data.

Data:-

Standard heat of formation of CO_2 (g) =-393.51 KJ/mol

Standard heat of formation of H_2O (l) = -285.83 KJ/mol

Standard heat of combustion of benzoic acid crystals = - 3226.95 KJ/mol

b) Ethylene oxide is produced by oxidation of ethylene. 100 kmoles of ethylene is fed to a reactor and product is found to contain 80 kmol ethylene oxide and 10 kmol CO_2. Calculate (i) conversion of ethylene: (ii) Yield of ethylene oxide.

c) Oxidation of ethylene to produce ethylene oxide is given by the reaction.

$$C_2H_4 + \frac{1}{2} O_2 \longrightarrow C_2H_4O$$

If air is used 20% in excess of that theoretically required, calculate the quantity of air supplied based on 100 Kmol of ethylene fed to reactor.

Q6. Attempt any three. **Marks: 12**

a) Calculate the standard heat of reaction of the following reaction.

$$C_5H_{12\,(l)} + 8O_{2\,(g)} \longrightarrow 5CO_{2\,(g)} + 6H_2O_{\,(l)}$$

Data

Component	ΔH^0_f KJ/mol at 298 K
$C_5H_{12\,(l)}$	-173.49
$CO_{2\,(g)}$	-393.51
H_2O (l)	-285.83

b) Calculate the heat needed to raise the temperature of 1 Kmol of ammonia from 311^0 k to 422^0 K using meal molal heat capacity

Cp^0_m for NH_3 between 311^0 and 298^0 K = 35.86 KJ/mol.K

Cp^0_m for NH_3 between 422^0k and 298^0 K = 37.70 KJ/mol.K.

c) A single effect evaporator is fed with 1000 kg/hr of weak liquor containing 20% caustic by weight and is concentrated to get thick liquor containing 50% caustic by weight. Calculate

(i) kg/hr of water evaporated

(ii) kg/hr of thick liquor obtained

d) A sample of coal is found to contain 63% carbon & 24% ash on weight basis. The analysis of refuse after combustion shows 7% carbon and rest ash. Calculate Kg of carbon in refuse.