

**B.TECH SEM - III (2007 COURSE) (CHEMICAL ENGG.) : WINTER
- 2017**

SUBJECT : STOICHIOMETRY

Day : **Monday**
Date : **22/01/2018**

W-2017-2356

Time : **10.00 AM TO 01.00 PM**
Max. Marks : 80

N.B.:

- 1) **Q.No.1** and **Q.No.5** are compulsory. Out of the remaining questions attempt **ANY TWO** questions from each section.
- 2) Answers to both the sections should be written in the **SEPARATE** answer books.
- 3) Use of non programmable **CALCULATOR** is allowed.
- 4) Draw neat and labeled diagrams **WHEREVER** necessary.
- 5) Figures to the right indicate **FULL** marks.

SECTION - I

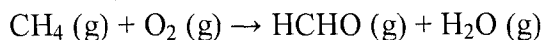
- Q.1 a)** A producer gas has the following composition by volume: **[04]**
CO = 21%, CO₂ = 5%, O₂ = 3% and N₂ = 71%.
Calculate the volume of gas in m³ at 298 K and 99.325 kPa per kg of carbon present.
- b)** Dryer system handles 1000 kg/day of wet solids. Wet solids containing 50% solids and 50% water are fed to the first dryer. From the first dryer the product that comes out has 20% moisture. This is admitted to the second dryer from which the product coming out has 2% moisture. Calculate the percentage of original water that is removed in each dryer and final weight of the product. **[06]**
- c)** Explain bypass operation carried out in the chemical industry with their block diagram. **[04]**
- Q.2 a)** A solution containing 55% benzene (C₆H₆), 28% toluene (C₆H₅CH₃) and 17% xylene [C₆H₄(CH₃)₂] by weight is in contact with its vapour at 373K. Calculate the total pressure and molar composition of the liquid and vapour. **[07]**
Data : Vapour Pressure data at 373K :
Benzene = 178.60 kPa, Toluene = 74.60 kPa, Xylene = 28 kPa.
- b)** Make the following conversions: **[06]**
i) 294 gm/lit H₂SO₄ to normality.
ii) 54.75 gm/lit HCl to molarity.
iii) 3M K₂SO₄ to gm/lit.
- Q.3 a)** A multiple effect evaporator system has a capacity of processing 1000 kg per day of solid caustic soda when it concentrates weak liquor from 4 to 25% by weight caustic soda. When the same plant is fed with 10% weak liquor and if it is concentrated to 50% (both on weight basis), find the capacity of the plant in terms of solid caustic soda. Assume that the water evaporating capacity to be same in both cases. **[07]**
- b)** The waste acid from a nitrating process containing 20% HNO₃, 55% H₂SO₄ and 25% H₂O by weight is to be concentrated by addition of concentrated sulphuric acid containing 95% H₂SO₄ and concentrated nitric acid containing 90% HNO₃ to get desired mixed acid containing 26% HNO₃ and 60% H₂SO₄. Calculate the quantities of waste and concentrated acids required for 1000 kg of desired mixed acid. **[06]**

P.T.O.

- Q.4 a)** Chlorobenzene is nitrated using a mixture of nitric acid and sulphuric acid. [09]
 During the pilot plant studies, a charge consists of 100 kg chlorobenzene (CB), 106.5kg 65.5% (by weight) nitric acid and 108.0 kg 93.6% (by weight) sulphuric acid. After two hours of operation, the final mixture was analysed. It was found that the final product contained 2% unreacted chlorobenzene. Also, the product distribution was found to be 66% p-nitrochlorobenzene (p-NCB) and 34% O-nitrochlorobenzene (O-NCB). Calculate :
- The analysis of charge
 - The percentage conversion of chlorobenzene
 - The composition of the product mixture.
- b)** Explain limiting reactant and excess reactant. [04]

SECTION – II

- Q.5 a)** Explain in detail ultimate and proximate analysis of coal. [06]
- b)** Calculate the enthalpy change between reactants and products if both are at 298.15 K and if 10 mol of formaldehyde is produced according to the following reaction: [04]

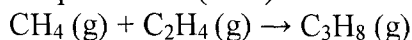


Data:

Component	$\Delta H_c^0, \text{kJ/mol}$
CH ₄ (g)	- 890.65
HCHO (g)	- 563.46

- c)** Explain humid heat and humid volume. [04]
- Q.6 a)** A mixture of acetone vapour and nitrogen contains 14.8% acetone by volume. [07]
 Calculate the following at 293K and pressure of 99.33 kPa.
- Partial pressure of acetone.
 - Moles of acetone per moles of nitrogen.
 - Relative saturation of mixture at 293K.
- Data: vapour pressure of acetone at 293K = 24.638 kPa.
- b)** Explain in detail humidification and dehumidification operation [06]

- Q.7 a)** Obtain an empirical equation for calculating the heat of reaction at any [09]
 temperature T (in K) for the following reaction:



Data: ΔH_r^0 at 298K = -82.66 kJ/mol

$$C_p^0 = a + bT + cT^2 + dT^3 \dots (\text{kJ/kmol.K}).$$

Component	a	$b \times 10^3$	$c \times 10^6$	$d \times 10^9$
CH ₄ (g)	19.2494	52.1135	11.973	- 11.3173
C ₂ H ₄ (g)	4.1261	155.0213	- 81.5455	16.9755
C ₃ H ₈ (g)	- 4.2227	306.264	-158.6316	32.1455

- b)** Explain Hess's law of constant heat summation. [04]
- Q.8 a)** The ultimate analysis of a residual fuel oil (RFO) sample is as given below: [09]
 C = 88.4%, H = 9.4%, S = 2.2% (by weight).
 Calculate:
- The theoretical dry air requirement.
 - The actual dry air supplied.
 - The Orsat analysis of flue gases.
- b)** Explain gross calorific value (GCV) and net calorific value (NCV) of fuel. [04]