Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

BE- IVth SEMESTER–EXAMINATION – MAY/JUNE- 2012

Subject code: 140504 Date: 31/05/2012

Subject Name: Fundamental Chemical Engineering Calculations & Stoichiometry

Time: 10:30 am – 01:00 pm Total Marks: 70

Instructions:

1. **Attempt all questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Figures to the right indicate full marks.**
4. **Atomic mass: C:12, O:16, H:1**

Q.1 **(a)** Ina double effect evaporator plant, the second effect is maintained under vacuum of 475 Torr (mm Hg). Find the absolute pressure in KPa, bar, psi, N/m^2, atm and kgf/cm^2. **07**

(b) Glycerin ($C_3H_8O_3$) weighing 800 mg is dissolved in pure water to make a final solution of 1 liter. Find TOC and ThOD of the solution. **07**

Q.2 **(a)** An aqueous solution of acetic acid (CH_3COOH) of 35% concentration by mass has a density of 1.04 kg/liter at 25 ^{0}C. Find the molarity, normality and molality of the solution. **07**

(b) A gas mixture has following composition by volume: CH_4 : 40%, C_2H_6 : 35%, C_3H_8: 25%. Find the average molecular mass of the gas mixture. Also find the density of mixture in kg/m^3 at NTP. **07**

OR

(b) Explain Dalton's law, Roult's law, Henry's law, BOD, COD, pH and specific gravity. **07**

Q.3 **(a)** What is material balance? What is process flow chart? Explain importance of process chart in chemical industry. **07**

(b) Explain Recycling and bypassing with reference to Chemical Industry. **07**

OR

Q.3 A multiple-effect-evaporator system has a capacity of processing one tonne per day of solid caustic soda when it concentrates weak liquor from 4 to 25%(both on weight basis). When the plant is fed with 5% weak liquor and if it is to be concentrated to 50% (both on weight basis), find the capacity of the plant in terms of solid caustic soda, assuming water evaporating capacity to be same in both the cases. **14**

Q.4 **(a)** The average molecular mass of a flue gas sample is calculated by two different engineers. One engineers uses the correct molecular mass of 28 for N_2 and determines the average molecular mass to be 30.08, the other engineers, using an incorrect value of 14, calculates the average molecular mass to be 18.74. **07**

(a) Calculate the volume% of N_2 in the flue gases.

(b) If the remaining components of the flue gases are CO_2 and O_2, calculate the volume % of each of them.

(b) A heat exchanger for cooling a hot hydrocarbon liquid uses 10000 kg/hr of cooling water, which enters the exchanger at 294 K. The hot oil at the rate of 5000 kg/hr enters at 423 K and leaves at 338 K and has an average heat capacity of 2.51 KJ/(kg.K). Calculate the outlet temperature of water. **07**

OR

Q.4 **(a)** Define the following for air-water system: **07**
Dry bulb temperature, Wet bulb temperature, Absolute humidity, Relative humidity, Percentage humidity, Humid heat and Humid volume.

(b) Define the following unit operations with suitable example: Distillation, Absorption, Extraction, Crystallization and Evaporation. **07**

Q.5 **(a)** The analysis of the gas entering the secondary converter in a contact sulphuric acid plant is 4% SO_2, 13% O_2 and 83% N_2 (on volume basis). The gas leaving the converter contains 0.45% SO_2 on SO_3-free basis (by volume). Calculate the percentage of SO_2 entering the converter getting converted to SO_3. **07**

(b) Pure methane is heated from 30 ^{0}C to 250 ^{0}C at atmospheric pressure. Calculate the heat added per kmol methane using the following data: **07**
$C_P = 19.2494 + 52.1135 \times 10^{-3} T + 11.973 \times 10^{-6} - 11.3173 \times 10^{-9}$ KJ/Kmol K.

OR

Q.5 **(a)** Obtain the expression relating the heat of reaction and the temperature of reaction. **07**

$$SO_{2(g)} + ½\ O_{2(g)} = SO_{3(g)}$$

Also calculate the heat of reaction at 700 K using the following C_p^0 data. $C_p^0 = a + bT + cT^2$ KJ/Kmol K

	ΔH^0_{f298} (KJ/gmol-K)	a	b x 10^3	c x 10^6
SO_2	-296.81	24.77	62.95	-44.26
O_2	0.0	26.026	11.755	-2.3426
SO_3	-395.72	22.04	121.6	-91.87

(b) Define sensible heat, latent heat, heat of formation, heat of combustion and standard heat of reaction. **07**

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