

**GUJARAT TECHNOLOGICAL UNIVERSITY****BE- IV<sup>th</sup> 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) In a 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<sup>2</sup>, atm and kgf/cm<sup>2</sup>. **07**
- (b) Glycerin (C<sub>3</sub>H<sub>8</sub>O<sub>3</sub>) 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<sub>3</sub>COOH) of 35% concentration by mass has a density of 1.04 kg/liter at 25 °C. Find the molarity, normality and molality of the solution. **07**
- (b) A gas mixture has following composition by volume: CH<sub>4</sub> : 40%, C<sub>2</sub>H<sub>6</sub> : 35%, C<sub>3</sub>H<sub>8</sub> : 25%. Find the average molecular mass of the gas mixture. Also find the density of mixture in kg/m<sup>3</sup> at NTP. **07**

**OR**

- (b) Explain Dalton's law, Raoult'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 engineer uses the correct molecular mass of 28 for N<sub>2</sub> and determines the average molecular mass to be 30.08, the other engineer, using an incorrect value of 14, calculates the average molecular mass to be 18.74.
- (a) Calculate the volume% of N<sub>2</sub> in the flue gases. **07**
- (b) If the remaining components of the flue gases are CO<sub>2</sub> and O<sub>2</sub>, 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**

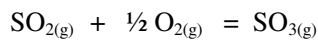
**OR**

- 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<sub>2</sub>, 13% O<sub>2</sub> and 83% N<sub>2</sub> (on volume basis). The gas leaving the converter contains 0.45% SO<sub>2</sub> on SO<sub>3</sub>-free basis (by volume). Calculate the percentage of SO<sub>2</sub> entering the converter getting converted to SO<sub>3</sub>. **07**
- (b)** Pure methane is heated from 30 °C to 250 °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**



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

	$\Delta H_{f298}^0$	a	$b \times 10^3$	$c \times 10^6$
	(KJ/gmol-K)			
SO <sub>2</sub>	-296.81	24.77	62.95	-44.26
O <sub>2</sub>	0.0	26.026	11.755	-2.3426
SO <sub>3</sub>	-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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