Enrolment No./Seat No_____

GUJARAT TECHNOLOGICAL UNIVERSITY

BE - SEMESTER–III (NEW) EXAMINATION – SUMMER 2024

Subject Code:3130508 Date:06-07-2024

Subject Name: Material & Energy Balance Computation

Time:10:30 AM TO 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. **Simple and non-programmable scientific calculators are allowed.**
5. **Atomic mass: C:12,O:16; P:31,Cl:35.5,H:1**

			MARKS
Q.1	**(a)**	Define the following: (1) Normality (2) Molarity (3) Molality	**03**
	(b)	Write the dimension of the following derived quantities: Volume, Pressure, Power, and Acceleration	**04**
	(c)	An aqueous solution of NaCl of 15% concentration (by mass) has a density of 1.127 kg/L at 50 ^{0}C. Find the molarity, normality, and molality of the solution.	**07**
Q.2	**(a)**	Discuss about recycling and bypassing operations.	**03**
	(b)	Make the following conversions: (i) 294 g/l H_2SO_4 to molarity (ii) 54.75 g/l HCl to normality	**04**
	(c)	For carrying out nitration reaction, it is desired to have a mixed acid containing 39% HNO_3, 42% H_2SO_4 (by mass). Nitric acid of 69 % (by mass) is readily available. Calculate: (a) the required strength of sulphuric acid to obtain the above mixed acid and (b) the mass ratio of nitric acid to sulphuric acid to be mixed.	**07**
		OR	
	(c)	A gas mixture has the following composition by volume: 35% methane, 15% ethane, 20% ethylene, 7% propane, 8% propylene and rest n-butane. Find: (a) the average molar mass of the gas mixture, (b) the composition by mass and (c) the specific gravity of gas mixture.	**07**
Q.3	**(a)**	How problems of material balance without chemical reactions are solved?	**03**
	(b)	With the typical example explain electrochemical reactions and calculation procedure of current efficiency.	**04**

(c) The spent acid from a nitrating process contains 40% H_2SO_4, 20% HNO_3 and 40% H_2O by weight. This acid is to be strengthened by addition of concentrated sulfuric acid containing 99% H_2SO_4 and concentrated nitric acid containing 95% HNO_3. The strengthened mixed acid is to contain 50% H_2SO_4, 40% HNO_3 and 10% water. Calculate the quantities of concentrated acids that should be mixed with 1000 kg of spent acid to get desired mixed acid. **07**

OR

Q.3 **(a)** Explain with a typical example, material and energy balance over distillation column. **07**

(b) In a silver electroplating plant, silver nitrate is used. When 1130 amperes were passed through $AgNO_3$ solution for 32400 sec, it was found that 2.0 m^3 oxygen (at NTP) was liberated at the anode. Calculate (a) the amount of silver liberated in kg and (b) the current efficiency of the cell. **07**

Q.4 **(a)** Discuss about material and energy balance for evaporator. **03**

(b) The gaseous reaction A = 2B + C takes place isothermally in a constant pressure reactor. Starting with a mixture of 75% A and 25% inert (by volume), at a specified time the volume doubles. Calculate the conversion achieved. **04**

(c) A spent solution of Chloroacetic acid (Mol. Wt.: 94.5) in ether (Mol. Wt.:74.0) contains 20 mole % chloroacetic acid. It is desired to make 500 kg of a saturated solution at 298 K. Find the quantities of spent solution and Chloroacetic acid required to make the above solution. **07**

Data: The solubility of Chloroacetic acid in ether is 190g/ 100g ether at 298 K.

OR

Q.4 **(a)** Using Watson equation, calculate latent heat of vaporization of acetone at 381 K. **03**

Data: Latent heat of acetone at 329.4 K = 29121 kJ/kmol
Critical temperature of acetone = 508.1 K.

(b) Define: **04**

Dew point, Dry bulb temperature, Wet bulb temperature, Absolute humidity.

(c) Discuss standard heat of reaction. Also discuss effect of temperature on heat of reaction. **07**

Q.5 **(a)** Discuss classification of fuel and the terms used for calorific value of fuel. **07**

(b) Discuss the Dulong formula and Calderwood equation and importance of the same with a typical example. **07**

OR

Q.5 **(a)** Discuss about proximate & ultimate analysis of coal. **07**

(b) A furnace is fired with fuel oil. The Orsat analysis of flue gases by volume is as given below: **07**

CO_2 = 10.6%, O_2 = 6% and N_2 = 83.4%

Calculate:

(a) the percent excess air used and
(b) the C: H ratio in the fuel oil, assuming that the fuel does not contain nitrogen.

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