Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

BE - SEMESTER–III(NEW) EXAMINATION – SUMMER 2023

Subject Code:3130508 Date:01-08-2023

Subject Name:Material & Energy Balance Computation

Time:02:30 PM TO 05:00 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 Na = 23, S = 32, Cl = 35.5, N = 14**

			MARKS
Q.1	**(a)**	Explain Ideal gas law, Dalton's law and Raoult's law.	**03**
	(b)	In double effect evaporator plant the second effect is maintain under the vacuum of 475torr (mmHg). Find the absolute pressure in kgf/cm^2, atm, kPa, bar.	**04**
	(c)	2000 kg of wet solids containing 70% solids by weight are fed to a tray dryer where it is dried by hot air. The product finally obtained is found to contain 1% moisture by weight, calculate: (a) the kg of water removed from solids, (b) the kg of product obtained.	**07**
Q.2	**(a)**	Define : Latent heat of vaporization, latent heat of fusion and Latent heat of sublimation	**03**
	(b)	In production of Sulphur trioxide, 100 kmol of SO_2 and 100 kmol of O_2 are fed to a reactor. The product stream is found to contain 80 kmol SO_3. Find the percent conversion of SO_3.	**04**
	(c)	Sodium chloride weighing 300 kg is mixed with 500 kg potassium chloride. Calculate the composition of the mixture in (i) weight % (ii) mol%	**07**
		OR	
	(c)	A solution of caustic soda contains 30% NaOH by weight. Taking density of the solution as 1.196 kg/L. find the normality, molarity and molality of the solution.	**07**
Q.3	**(a)**	How many moles of H_2SO_4 will contain 64 kg of S?	**03**
	(b)	Define : (a) Yield (b) Conversion (c) Limiting reactant (d) Excess reactant	**04**
	(c)	4000 kg of mixture of benzene and toluene containing 50 mole% benzene is distilled to get an overhead product containing 95 mole% benzene and a residue containing 90 mole% toluene. Calculate the weights of benzene and toluene in feed, distillate and residue.	**07**
		OR	
Q.3	**(a)**	Define Normality, Molarity&Molality.	**03**
	(b)	Estimate the consumption of ammonia and air for production of 3000 kg of nitric acid per hour. The yield of	**04**

NO is 97% the yield of HNO_3 is 92% and the content of NH_3 in the dry NH_3-air mixture is 7% by weight.

(c) The dilute acid containing 20% H_2SO_4 is concentrated by commercial grade sulphuric acid containing 98% $H_2SO_4$to obtain desired acid containing 65% H_2SO_4. Find the quantities of the acids required to make 1000 kg of desired acid. **07**

Q.4 **(a)** Give classification of fuel in brief. **03**

(b) Calculate the heat needed to raise the temperature of 1 kmol of ammonia from 311 K to 415 K using the mean molal heat capacity.. **04**

Data: $C^{\circ}_{pm}$for NH_3 between 311 K and 298 K = 35.8641 kJ/(kmol.K)

$C^{\circ}_{pm}$for NH_3 between 415 K and 298K = 37.7063kJ/(kmol.K)

(c) In manufacture of chlorine, feed containing hydrochloric acid gas and air are fed to an oxidizer. The product gases leaving the oxidizer are found to contain 13.2% HCl, 7.6 %O_2, 42.9% N_2, 30% Cl_2 and 6.3% H_2O (by weight). Calculate : **07**

(a) the percent excess air used,

(b) the composition by weight of gases entering the oxidizer,

(c) the degree of completion of oxidation.

OR

Q.4 **(a)** Explain importance of material and energy balance computations in chemical engineering **03**

(b) A stream of oxygen flowing at a rate of 200 kmol/hr is heated from 303 K to 373 K. Calculate the heat that must be transferred. **04**

(c) In the Decon process for the manufacture of chlorine, a dry mixture of hydrochloric acid gas and air is passed over a heated catalyst which promotes oxidation of acid. Air is used 30% excess of that theoretically required. Calculate the weight of air supplied per kilogram of the acid. **07**

(Atomic weight of Air contains 23.2% O_2 by weight)

Q.5 **(a)** Calculate the heat that must be added to 3 kmol air to heat it from 298 K to 473 K sing mean molal heat capacity data for air given below: **03**

$C^{\circ}_{pm}$for air = 29.3955 kJ/(kmol.K)

(b) Define terms : Heat of reaction, Heat of formation, Heat of combustion, Adiabatic process **04**

(c) Discuss Proximate and Ultimate analysis of coal. **07**

OR

Q.5 **(a)** Differentiate Endothermic and exothermic reactions. **03**

(b) State Hess's law of constant heat summation **04**

(c) Define GCV and NCV for fuels and its importance. List out the equipment's used for measuring CV of solid, liquid and gases. **07**

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