Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

BE - SEMESTER–IV(OLD) • EXAMINATION – WINTER 2016

Subject Code:140504 **Date:24/11/2016**

Subject Name:Fundamental Chemical Engineering Calculations & Stoichiometry

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.**

Q.1 **(a)** Differentiate between fundamental units & derived units. **07**

(b) 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^2, atm and kgf/cm^2. **07**

Q.2 **(a)** Discuss methods of solving material balance problems without chemical reaction. **07**

(b) The diameter and height of a vertical cylindrical tank are 5 ft and 6 ft 6 inch respectively. It is full up to 50% height with water, the density of which is 1 kg/liter. Find the mass of water in kilograms and pounds. **07**

OR

(b) Vapour pressure of benzene in the temperature range of 7.5°C to 104°C can be calculated using following equation **07**

$$\log 10p = 6.9057 + \frac{1211.0}{(t + 220.8)}$$

Where, p = vapour pressure in Torr

T = temperature in °C

Convert the above equation in SI units.

Q.3 **(a)** Define following with respect to material balance with chemical reaction: **07**

(1) Stoichiometric coefficient (2) Limiting Reactant

(3) Excess Reactant (4) Percent Excess

(5) Conversion (6) Yield

(7) Selectivity

(b) In the Deacon 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% in excess of that theoretically required. The reaction taking place is **07**

$$4HCl + O_2 \longrightarrow 2Cl_2 + 2H_2O$$

(1) Calculate the weight of air supplied per kg of the acid.

(2) Calculate the composition by weight of the gas entering the reaction chamber

OR

Q.3 **(a)** The solution of NaCl in water contains 20% NaCl (by mass) at 60°C. The density of the solution is 1.127 kg/L. Fing molarity, normality and molality of the solution. **07**

(b) With a neat sketch show the material balance for the following unit operation: **07**

(1) Extraction

(2) Evaporation

Q.4 **(a)** It is required to make 1000 kg mixed acid containing 60% H_2SO_4, 32% HNO_3, and 8% water by blending the spent acid containing 11.3% HNO_3, 44.4% H_2SO_4, 44.3% H_2O, aqueous 90% HNO_3 and aqueous 98% H_2SO_4. All % are by weight. Calculate the quantities of each of the three acids required for mixing **07**

(b) Explain recycle stream, bypass stream and purge stream. Draw proper diagrams and give examples. **07**

OR

Q.4 **(a)** The analysis of sewage gas sample from municipal sewage treatment plant is given below on a volume basis: **07**

CH_4 = 68%, CO_2 = 30%, NH_3 = 2% and H_2S, SO_2 = traces. Calculate:

(1) the average molar mass of the gas.

(2) Density of gas at NTP

(b) Define following with respect to energy balance:

(1) Heat Capacity (2) Standard heat of reaction

(3) Heat of Combustion (4) Standard heat of formation

07

Q.5 **(a)** A producer gas with the composition by volume 27.3% CO, 5.4% CO_2, 0.6% O_2, 66.7% N_2 is burnt with 20% excess air. If the conversion is 98% complete, calculate the composition by volume of flue gages. **07**

(b) Define the following terms with reference to air-water humidification operation: **07**

(1) Dry-bulb temperature (2) Absolute humidity

(3) Percentage humidity (4) Relative humidity

(5) Humid heat (6) Dew point

(7) Humid volume

OR

Q.5 **(a)** An approximation equation for C_p (cal/gm mol K) of gaseous HCl is **07**

$$Cp = 6.6 + 0.96\times10^{-3}\,T$$

Calculate the heat required to raise the temperature of 1gm mol of gas from 100 to 200°C.

(b) Differentiate between: **07**

(1) Sensible heat and latent heat

(2) Endothermic and exothermic reactions

(3) Internal energy and external energy

(4) BOD and COD.

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