Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

BE - SEMESTER– IV(NEW) EXAMINATION – SUMMER 2015

Subject Code: Stoichiometry **Date:**30/**05/2015**

Subject Name: 2140406

Time: 10:30am-1.00pm **Total Marks: 70**

Instructions:

1. **Attempt all questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Figures to the right indicate full marks.**
4. **Notations used have their conventional meanings.**

Q.1 **(a)** The conductance of a fluid-flow system is defined as the volumetric flow rate, referred to a pressure of one torr (133.322 Pa.). For an orifice, the conductance C can be computed from **07**

$$C = 89.2A\sqrt{\frac{T}{M}}\, ft^3/s$$

Where A = area of opening in ft^2

T = Temperature in Rankine

M = Molecular Weight

Convert the empirical equation into SI units.

(b) Write a short note on recycling and bypassing operations with their importance in the process industries. **07**

Q.2 **(a)** Define the following: **07**

i) % conversion ii) % excess

iii) % yield iv) limiting reactant

v) standard heat of reaction vi) standard heat of formation

vii) latent heat

(b) The gaseous reaction A → 2B + C takes place isothermally in a constant pressure reactor. Starting with a mixture of 75% A and 25% inerts (by volume), in a specified time the volume doubles. Calculate the conversion achieved. **07**

OR

(b) Cracked gas from a petroleum refinery has the following composition by volume: Methane 45%, Ethane 10%, Ethylene 25%, Propane 7%, Propylene 8%, n-Butane 5%. **07**

Find: i) average molecular weight of the mixture, and ii) the composition by weight %.

Q.3 **(a)** Find the heat that must be transferred to heat a mixture of 25 mol% N_2 and 75 mol% H_2 from 298 K to 473 K flowing at a rate of 1.5 kmol/h. **07**

Heat capacity data:

$Cp\ (kJ/kmol.K) = a + bT + cT^2 + dT^3$

Gas	**a**	**b × 10^3**	**c × 10^6**	**d × 10^9**
N_2	29.59	-5.41	13.18	-4.97
H_2	28.61	1.02	-0.15	0.77

(b) Formaldehyde is produced from methanol catalytic reactor. The production rate of formaldehyde is 1000 kg/h. If conversion of methanol is 65%, calculate the required feed rate of methanol. **07**

OR

Q.3 **(a)** Find out the value of the universal gas constant R in following units: **07**

i) atm.lit/gmol.K
ii) J/gmol.K
iii) cm^3.atm/kmol.K
iv) kPa.m^3/kmol.K

(b) Discuss the methods of solving material balance problems without chemical reactions. **07**

Q.4 **(a)** A solution containing 55% benzene, 28% toluene and 17% xylene by weight is in contact with its vapour at 373 K. Calculate the total pressure and molar composition of the liquid and vapour phases. **07**

Vapour pressure data at 373 K:

Benzene : 178.6 kPa
Toluene : 74.6 kPa
Xylene : 28 kPa

(b) An evaporator system concentrating weak liquor from 5% to 50% solids handles 100 kg of solids per hour. If the same system is to concentrate a weak liquor from 4% to 35%, find the capacity of the system in terms of solids that can be handled per hour assuming water evaporation capacity to be same in both cases. **07**

OR

Q.4 **(a)** An aqueous solution of acetic acid of 35% by weight has a density 1.04 kg/lit at 298 K. Find the molarity, normality and molality of the solution. **07**

(b) The average molar mass of a flue gas sample is calculated by two different engineers. One engineer uses the correct molar mass of 28 for N_2 and determines the average molar mass to be 30.08, the other engineer, using an incorrect value of 14, calculates the average molar mass to be 18.74. Calculate the volume % of N_2 in the flue gases. If the remaining components of the flue gases are CO_2 and O_2 then calculate the volume % of each of them. **07**

Q.5 **(a)** Define the following with respect to humidification operations: **07**

i) absolute humidity
ii) molal humidity
iii) dry-bulb temperature
iv) wet-bulb temperature
v) relative humidity
vi) percentage humidity
vii) dew point

(b) With a neat sketch show the material balance for the following unit operations: **07**
i) distillation, and ii) evaporation

OR

Q.5 **(a)** In the Deacon process for manufacture of Chlorine, hydrochloric gas is oxidized with air. The reaction taking place is: **07**

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

The air used is in excess of 30% of that theoretically required and the oxidation is 80% complete. Calculate the composition by volume of dry gases leaving the reaction chamber.

(b) The molal heat capacity of CO is given by $C_P = 26.586 + 7.582*10^{-3} T - 1.12*10^{-6} T^2$ where C_P is in kJ/(kmol.K) and T is in K. Calculate the mean molal heat capacity in the temperature range of 500K-1000 K. **07**

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