Seat No.: _____ Enrolment No.

GUJARAT TECHNOLOGICAL UNIVERSITY

BE – SEMESTER – IV • EXAMINATION – WINTER 2017

Subject Code: 140504 **Date: 29/11/2017**

Subject Name: Fundamental Chemical Engineering Calculations & Stoichiometry

Time: 02.30PM 05.00PM **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)** Classify the material balance. Discuss the various methods involved for solving material balance problems without chemical reactions. **07**

(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**

Q.2 **(a)** The diameter and height of a vertical cylindrical tank are 4 ft and 6 ft 6 inch respectively. It is full up to 80% height with carbon tetrachloride, the density of which is 1.6 kg/*l*. Find the mass in kilograms and pounds. **07**

(b) 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, ft^2; T = Temperature, ^0R; M = Molecular Weight
Convert the empirical equation into SI units.

OR

(b) Discuss about recycling and bypassing operations with their importance. **07**

Q.3 **(a)** With a typical example, explain the terms: Conversion, Yield, Selectivity, Limiting component and Excess component. **07**

(b) Differentiate between: (i) Sensible heat and latent heat (ii) Endothermic and exothermic reactions (iii) intensive property and extensive property. **07**

OR

Q.3 **(a)** A gas mixture has following composition by volume: CH_4: 40%, C_2H_6: 35%, C_3H_8: 25%. Find the average molecular mass of the gas mixture. Also find the density of mixture in kg/m^3 at STP. **07**

(b) 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_2 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. Calculate the volume % of N_2 in the flue gases. If the remaining components of the flue gases are CO_2 and O_2, calculate the volume % of each of them. **07**

Q.4 **(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. Heat capacity data: Cp (kJ/kmol.K) = $a + bT + cT^2 + dT^3$ **07**

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

(b) What will be the composition of gases obtained by burning pure FeS$_2$ with 60% excess air? Assume that the reaction proceeds in the following manner. **07**

$$4FeS_2(s) + 11O_2(g) \rightarrow 2Fe_2O_3(s) + 8SO_2(g)$$

OR

Q.4 **(a)** A spent lye sample contains 9.6% glycerol and 10.3% NaCl salt. It is concentrated at the rate of 5000 kg/h in a double effect evaporator until the final solution contains 80% glycerol and 6% salt. 45% glycerol is lost by entrainment. All the percentage are by mass. Determine: **07**

(i) the evaporation taken place in the system

(ii) the amount of salt crystallized out from the evaporator

(b) Pure methane is heated from 303K to 523K at atmospheric pressure. Calculate the heat added per kmol of methane using the following Cp data. **07**

$$Cp = a + bT + cT^2 + dT^3$$

Where a = 19.2494, b × 10^3 = 52.1135, c × 10^6 = 11.973, d × 10^9 = -11.3173

Q.5 **(a)** Define the following unit operations with suitable diagram and example: distillation, crystallization and evaporation. **07**

(b) Define the following terms with supporting equations: (i) Absolute humidity (ii) Relative humidity (iii) Humid heat **07**

OR

Q.5 **(a)** It is required to make 1000 kg mixed acid containing 60% H_2SO_4, 32% HNO_3 and 8% water by blending (i) spent acid containing 11.3% HNO_3, 44.4% H_2SO_4 and 44.3% H_2O, (ii) aqueous 90% HNO_3 and (iii) aqueous 98% H_2SO_4. All percentage are by weight. Calculate the quantities of each of the three acids required for blending. **07**

(b) The dry bulb temperature & dew point of ambient air were found to be 302 K & 291 K respectively. The barometer reads 100 kPa, calculate : a) the absolute molal humidity, b) the absolute humidity, c) % RH, d) % saturation, e) humid heat, and f) humid volume. **07**

Data : Vapour pressure of water at 291 K = 2.0624 kPa

Vapour pressure of water at 302 K = 4.004 kPa

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