

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 $A \rightarrow 2B + C$ 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**

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

Where A = area of opening, ft^2 ; T = Temperature, $^{\circ}\text{R}$; 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**

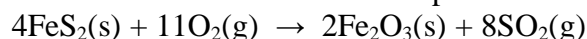
OR

- 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: $C_p (\text{kJ/kmol.K}) = a + bT + cT^2 + dT^3$ **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 with 60% excess air? Assume that the reaction proceeds in the following manner. **07**



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 C_p data. **07**

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

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

- 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
