Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

BE - SEMESTER–IV (New) EXAMINATION – WINTER 2015

Subject Code:2143507 Date:04/01/2016

Subject Name: Fundamental of stoichiometry

Time: 02:30pm to 05:00pm Total Marks: 70

Instructions:

1. **Attempt all questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Figures to the right indicate full marks.**
4. **Atomic weight: H: 1, C: 12, N: 14, O: 16, S: 32, Cl: 35.5, Cu=63.5.**

Q.1 **(a)** Convert 1 atm into equivalent N/m^2, m H_2O, ft H_2O, psi ,in Hg ,mm Hg, and kg_f/cm^2. **07**

(b) A weight of 1.10 kg of Carbon dioxide occupies a volume of 33 liter at 300 K. Using the Van der Waals equation of state, calculate the pressure. Data: For CO_2 , take a = 3. 60 $[(m^3)^2\text{-kPa}]/(kmol)^2$and b = 4.3 x 10^{-2} $m^3/kmol$. **07**

Q.2 **(a)** Explain Recycle, Purge, bypass with suitable diagram and also define the overall and single pass fraction conversion. **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 double. Calculate the conversion achieved. **07**

OR

(b) 1 kg nitrogen is mixed with 3.5 m^3 of hydrogen at 300 K and 101.3 kPa and sent to the ammonia converter. The product leaving the converter analyzed 13.7 % ammonia, 70.32 % hydrogen and 15.98 % nitrogen. **07**

i. Identity the limiting reactant.
ii. What is the present excess of excess reactant?
iii. What is the present conversion of the limiting reactant?

Q.3 **(a)** 2000 kg of wet solids containing 70 % solids by weight are fed to tray dryer where it is fried by hot air. The product finally obtained is found to contain 1% moisture by weight, calculate: (1) kg of water removed from wet solids (2) kg of the product obtained. **07**

(b) The average molecular weight of the flue gas sample is calculated by two different engineers. One engineer used the correct molecular weight of N_2 as 28, while the other used an incorrect value of 14. They got the average molecular weight as 30 and the incorrect one as 18.74. Calculate the % volume of N_2 in the flue gases. If the remaining gases are CO_2 and O_2 calculated their compositions also. **07**

OR

Q.3 **(a)** Define : (1) Yield (2) Conversion (3) Normality (4) Limiting Reactant (5) excess reactant (6) Selectivity (7) Molality. **07**

(b) A weak acid containing 12.5 % H_2SO_4 and the rest water is fortified by adding 500 kg of concentrated acid containing 80 % H_2SO_4. Determine the amount of the solution obtained if it contains 18.5 % H_2SO_4? **07**

Q.4 **(a)** A heat exchanger for cooling a hot hydrocarbon liquid uses 10000 kg/h of cooling water, which enters the exchanger at 294 K. The hot oil at the rate of 5000 kg/h enters at 423 K and leaves at 338 K and has an average heat capacity of 2.5 kJ/kg K. Calculate the outlet temperature of water. **07**

(b) Calculated the enthalpy of zinc vapour at 1200 ^{0}C and atmosphere pressure, **07**

relative to solid at 10 ^{0}C.
Data: Melting point of Zn = 419 ^{0}C (at 1 atm)
Boiling point of Zn = 907 ^{0}C (at 1 atm)
Mean C_p of solid Zn = 0.105 kcal/kg ^{0}C
Mean C_p of liquid Zn = 0.109 kcal/kg ^{0}C
Heat of fusion of Zn = 1660 kcal/kgmole
Heat of vaporization of Zn = 26900 kcal/kgmole
Mean Cp of Zinc vapour = 4.97 kcal/kgmole ^{0}C
Atomic weight of Zn = 65.4 kg/kgmole

OR

Q.4 **(a)** Heat capacity for gaseous SO_2 is given by the following equation: **07**

$C_P^0 = 43.458 + 10.634 \times 10^{-3} - 5.945 \times 10^5 T^2$

Calculated the heat required to raise the temperature of 1 kmol pure SO_2 from 300 K and 1000 K.

(b) Using Watson equation, calculate latent heat of vaporization of Acetone at 313K **07**
Carbon disulphide (CS_2) at 413 K.

T_1 (boiling point temp)	Component	Latent heat of vaporization at T_1, K (KJ/kmol)	T_c	n
329.4	Acetone (C_3H_6O)	29121	508.1	0.38
319	CS_2	26736	552.0	0.38

Q.5 **(a)** Calculate the theoretical flame temperature of gas having 20 % CO and 80 % N_2 burnt with 150 % excess air. Both air and gas are being at 25 ^{0}C. **07**
Data: heat of formation of CO_2 = -94,052 cal /gmol , CO = -26,412 cal/ gmol at 25 ^{0}C. Data :C_{pm} : CO_2 = 12.1 , O_2 = 7.9 , N_2 = 7.55 cal/ gmol K.

(b) Define the following terms: **07**
(1)Dry-bulb temperature (2) Wet bulb temperature (3)Latent heat (4) Absolute humidity (5) Relative humidity (6) Dew point (7) Humid heat

OR

Q.5 **(a)** **07**

$$SO_2 + \frac{1}{2} O_2 \rightarrow SO_3$$

calculate the heat of reaction at 700 K using the following.
$Cp^0 = a + bT + cT^2$ KJ/Kmol K

Comp.	$\Delta H^0_{f298\ (kJ/mol)}$	a	b x 10^3	c x 10^6
SO_2	-296.81	24.77	62.95	-44.26
O_2	0.0	26.026	11.755	-2.3426
SO_3	-395.72	22.04	121.6	-91.87

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

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