Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

B.E. Sem-III Remedial Examination May 2011

Subject code: 130504 **Subject Name: Process Calculation**

Date: 28-05-2011 **Time: 10.30 am – 01.30 pm**

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: K=39, Cl=35.5 Zn=65.4, Na=23**

Q.1 **(a)** A gas mixture has the following composition by volume: Ethylene-30.6%, Benzene-24.5%, Oxygen-1.3%, Methane-15.5%, Ethane-25%, Nitrogen-3.1%. Find out (a) The average molecular weight of gas mixture, (b) The composition by weight **08**

(b) An aqueous solution of K_2CO_3 is prepared by dissolving 43 kg K_2CO_3 in 100 kg water at 20^0c. The density of the solution is measured to be 1.3 kg/liter. Find out molarity, molality and normality of the solution. **06**

Q.2 **(a)** In the Deacon process for manufacturing chlorine, hydrochloric acid gas is oxidized with air. The reaction taking place is $4HCl + O_2 \rightarrow 2Cl_2 + 2H_2O$ If the air is used in excess of 30% of that theoretically required and if the oxidation is 80% complete, calculate the composition by volume of dry gases leaving the reaction chamber. **08**

(b) Calculate the following for the reaction: **06**

$C_2H_4 + 2Cl_2 \rightarrow C_2HCl_3 + H_2 + HCl$

(1) The stoichiometric ratio of Cl_2 to C_2H_4 (2) If 4 kmol Cl_2 is used per kmol of C_2H_4, find the % excess Cl_2 (3) the amount of HCl produced from 50 kg C_2H_4 assuming reaction goes to completion.

OR

(b) Define GCV and NCV for fuels. Give its importance. Also give the names of the equipments used for measuring CV of solid, liquid and gases. **06**

Q.3 **(a)** The diameter and height of a vertical cylindrical tank are 5ft and 6ft 6 inch respectively. It is full up to 75% height with carbon tetrachloride, the density of which is 1.6 kg/liter. Find the mass in kilograms. **04**

(b) Find the value of Universal gas constant R in following units. **10**

(1) atm.liter/gmmole.^{0}k
(2) m^3.atm/kmol. ^{0}k
(3) joule/gmmole.^{0}k
(4) cm^3. torr/gmmole.^{0}k

OR

Q.3 **(a)** In a double effect evaporator plant, the second effect is maintained under vacuum of 475 torr. Find the absolute pressure in kPa, bar and psi. **03**

(b) Iron metal weighing 500 lb occupies a volume of 29.25 liter. Calculate the density of Fe in gm/cm^3. **03**

(c) For carrying out nitration reaction, it is desired to have a mixed acid containing 39% HNO_3, 42% H_2SO_4 and 19% H_2O by weight. Nitric acid of 68.3% weight is readily available. Calculate: **08**

(1) The required strength of sulfuric acid to obtain the above mixed acid.

(2) Weight ratio of nitric acid to sulfuric acid to be mixed.

Q.4 **(a)** 1000 kg of sodium carbonate solution containing 25% sodium carbonate is subjected to evaporative cooling, during which process 15% of the water present in the solution is evaporated. From the concentrated solution $Na_2CO_3 .10H_2O$ crystallizes out. Calculate how much crystals would be produced if the solubility of $Na_2CO_3 .10H_2O$ is 21.5 gm per 100 gm of water. **07**

(b) Methanol and ethanol at 100^0c have vapor pressure of 2710 mm and 1635 mm Hg respectively. Calculate the total pressure and composition of the vapor in contact with a liquid containing 30% by weight methanol and rest ethanol at 100^0c. **07**

OR

Q.4 **(a)** The average molecular weight of a flue gas sample is calculated by two different engineers. One engineer uses the correct molecular weight of 28 for N_2 and determines the average molecular weight to be 30.08, the other engineer, using an incorrect value of 14, calculates the average molecular weight to be 18.74. **08**

(1) Calculate the volume % of N_2 in the flue gases.

(2) If the remaining components of the flue gases are CO_2 and O_2, calculate the volume % of each of them.

(b) Define and explain the following terms: **06**

(1)Heat of formation (2)Heat of combustion (3)Heat of reaction (4)Limiting reactant (5)Excess reactant (6)Conversion of reaction

Q.5 **(a)** A mixture of aniline and water containing 11.8% by weight of aniline is cooled from 100 to 40^0c with the help of cooling water. Find the amount of heat removed by cooling 100 kg of mixture. The specific heat C_p can be expressed by the equation. $C_p = a + bT + cT^2$ (kcal/kg.^{0}c) **08**

Where the constants a, b, c are :

For aniline: $a=1.407$, $b=2.467\times10^{-3}$, $c= -6.08\times10^{-6}$

For water: $a=0.6741$, $b=2.8\times10^{-3}$, $c=8.3\times10^{-6}$

(b) Explain the proximate and ultimate analysis of coal. **06**

OR

Q.5 **(a)** Calculate the enthalpy of zinc vapor at 1200^0c and atmospheric pressure, relative to solid at 10^0c. **09**

Data: Melting point of Zn = 419^0c (at 1 atm)

Boiling point of Zn = 907^0c (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 C_p of zinc vapor = 4.97 kcal/kgmole.^{0}c.

Atomic weight of Zn = 65.4 kg/kgmole

(b) Define with respect to humidification operation: **05**

(1) Absolute humidity

(2) Relative humidity

(3) Percent humidity

(4) Dry bulb temperature

(5) Wet bulb temperature

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