Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

BE - SEMESTER–III • EXAMINATION – WINTER • 2014

Subject Code: 130504 Date: 30-12-2014

Subject Name: Process Calculation

Time: 02.30 pm - 05.30 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 weights: C:12, H:1, N: 14, O:16, Na: 23, Cl:35.5, K:39**

Q.1 **(a)** A gas mixture has the following composition by volume: **08**
Ethylene: 30.6%, Benzene: 24.5%, Oxygen: 1.3%,
Methane: 15.5%, Ethane: 25.0%, Nitrogen: 3.1%. Find:
i) the average molecular weight of the gas mixture,
ii) the composition by weight, and
iii) the density of the mixture in kg/m^3 at 101.3 kPa and 273 K.

(b) Find out value of the universal gas constant R in the following units: **06**
i) atm.lit/mol.K
ii) J/mol.K
iii) cm^3.atm/kmol.K
iv) kPa.m^3/kmol.K

Q.2 **(a)** Classify the material balance. Discuss various methods involved for solving material balance problems without chemical reactions. **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, ^oR
M = molecular weight
Convert the empirical equation into equation with SI units.

OR

(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. **07**

Q.3 **(a)** Explain importance of process flow sheet in chemical industry with a typical example. **07**

(b) Write a short note on recycling and bypassing operations. **07**

OR

Q.3 **(a)** In the Deacon process for manufacturing chlorine, hydrochloric acid gas is oxidized with air. The reaction taking place is: **07**
$4HCl + O_2 \rightarrow 2Cl_2 + 2H_2O$
If 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.

(b) Heat capacity data for gaseous SO_2 are reported by following equation: **07**
$C^0_{mp} = 43.458 + 10.634 \times 10^{-3}T - 5.945 \times 10^5 / T^2$, J/mol.K
Calculate the heat required to raise the temperature of 1 mol pure sulphur dioxide from 300 K to 1000 K.

Q.4 **(a)** Define the following: **07**
i) heat of reaction
ii) heat of formation
iii) heat of combustion
iv) sensible heat
v) latent heat
vi) conversion
vii) yield

(b) Define GCV and NCV for fuels. Give its importance. Also give names of the equipments used for measuring CV of solids, liquids and gases. **07**

OR

Q.4 **(a)** In an electrochemical cell, the current is passed at the rate of 1130 amperes for 18000 seconds through a solution containing copper sulphate. At the end of the process, 1.12 m^3 oxygen (at NTP) is collected. Find: i) the amount of copper liberated, and ii) the current efficiency of the cell. **07**

(b) A solution of ethyl alcohol containing 8.6% alcohol is fed at rate of 1000 kg/h to a continuous distillation column. The product is a solution containing 95.5% alcohol. The waste solution from the column carries 0.1% alcohol. All % are by weight. Calculate i) the mass flow rate of top & bottom product in kg/h and ii) the % loss of alcohol. **07**

Q.5 **(a)** Discuss in brief about proximate analysis and ultimate analysis of coal. **07**

(b) Define the following terms with reference to air-water humidification operation: **07**
i) dry-bulb temperature
ii) absolute humidity
iii) percentage humidity
iv) relative humidity
v) humid heat
vi) humid volume
vii) dew point

OR

Q.5 **(a)** The Orsat analysis of the flue gases from a boiler house chimney gives CO_2: 11.4%, O_2: 4.2% and N_2: 84.4% (mol%). Assuming that complete combustion takes place, **07**
i) calculate the % excess air, and
ii) find C:H ratio in the fuel.

(b) A mixture of aniline and water containing 11.8% by weight of aniline is cooled from 100^0C to 40^0C with the help of cooling water. Find the amount of heat removed by cooling 100 kg of mixture. The specific heat Cp can be expressed by the equation. $Cp = a + bT + cT^2$ (kcal/kg.^{0}C) **07**
where the constants a, b, c are :
For aniline: $a = 1.407$, $b = 2.467 \times 10^{-3}$, $c = -6.08 \times 10^{-6}$
For water: $a = 0.6741$, $b = 2.8 \times 10^{-3}$, $c = 8.3 \times 10^{-6}$

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