

GUJARAT TECHNOLOGICAL UNIVERSITY
BE SEM-III Examination-Dec.-2011

Subject code: 130504**Date: 17/12/2011****Subject Name: Process Calculation****Time: 2.30 pm -5.30 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, O:16, Cl:35.5, N:14, K:39, Zn:65.4, Fe:56

- Q.1 (a)** 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**

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

Where A = area of opening, ft^2

T = temperature, $^{\circ}R$

M = molecular weight

Convert the empirical equation into SI units.

- (b)** In a double effect evaporator plant, the second effect is maintained under vacuum of 350 torr. Find the absolute pressure in kgf/cm^2 , kPa, atm, N/m^2 , bar, psi and mm Hg. **07**

- Q.2 (a)** A gas mixture has the following composition by volume: **07**
 C_2H_2 : 32.0%, C_6H_6 : 21.0%, Oxygen: 2.0%, CH_4 : 16.0%, C_2H_6 : 20.0%, Nitrogen: 9.0%.

Find: (a) the average molar mass of the gas mixture, (b) the composition by mass and (c) the density of gas mixture in kg/m^3 at 101.325 KPa and 300 K.

- (b)** An aqueous solution of K_2CO_3 is prepared by dissolving 43 kg K_2CO_3 in 100 kg water at 293 K. The density of the solution is measured to be 1.3 kg/l. Find the molarity, normality and molality of the solution. **07**

OR

- (b)** Explain importance of process flow sheet in Chemical Engineering Industry with a typical example. **07**

- Q.3 (a)** A multiple-effect-evaporator system has a capacity of processing one tonne per day of solid caustic soda when it concentrates weak liquor from 4 to 40% (both on weight basis). When the plant is fed with 5% weak liquor and if it is to be concentrated to 60% (both on weight basis), find the capacity of the plant in terms of solid caustic soda, assuming water evaporating capacity to be same in both the cases. **07**

- (b) The average molecular mass of a flue gas sample is calculated by two different engineers. One engineers uses the correct molecular mass of 28 for N₂ and determines the average molecular mass to be 30.08, the other engineers, using an incorrect value of 14, calculates the average molecular mass to be 18.74. Calculate the volume% of N₂ in the flue gases.
If the remaining components of the flue gases are CO₂ and O₂, calculate the volume % of each of them.

OR

- Q.3** (a) Discuss in detail about recycling and bypassing operations. 07
(b) A spent solution of Chloroacetic acid (ClCH₂COOH) in ether (C₂H₅-O-C₂H₅) contains 20 mole % chloroacetic acid. It is desired to make 1 ton of a saturated solution at 298 K. Find the quantities of spent solution and Chloroacetic acid required to make the above solution.
Data: Solubility of Chloroacetic acid in ether is 190g/100g ether at 298 K. 07

- Q.4** (a) A pilot plant reactor was charged with 50 kg naphthalene and 200 kg (98% by mass) H₂SO₄. The reaction was carried out for 3 hours at 433 K. The reaction goes near to completion. The product distribution was found to be 18.6% monosulphonate naphthalene and 81.4% disulphonate naphthalene. Calculate (a) the quantities of monosulphonate naphthalene(MSN) and disulphonate naphthalene (DSN) products, and (b) the complete analysis of the product. 07
(b) In the Deacon process for manufacturing chlorine, hydrochloric acid gas is oxidized with air. The reaction taking place is:
$$4\text{HCl} + \text{O}_2 = 2\text{Cl}_2 + 2\text{H}_2\text{O}$$

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. 07

OR

- Q.4** A mixture of pyrites and zinc sulphide ore is burnt in a burner. The mixture contains 75% pyrites and 25% zinc sulphide ore. The pyrites yield 92% FeS₂ and rest gangue. The zinc sulphide ore contains 68% ZnS and rest inerts. A sample of cinder yields 3.5% S. 70% of S in the cinder in the form of SO₃, absorbed in it, and rest is unoxidized FeS₂. All percentage are by weight. Based on 100 kg of mixed charge, calculate: (a) the amount of cinder formed with its analysis and (b) the percentage of sulphur left in the cinder based on the total sulphur charged. 14

- Q.5** (a) Define the following terms: 07
(1) Yield (2) Dew point (3) Latent heat (4) Dry-bulb temperature
(5) Absolute humidity (6) Wet bulb temperature (7) Limiting component
(b) Temperature of pure oxygen is raised from 350 to 1400 K. Calculate the amount of heat to be supplied for raising temperature of 1 kmol oxygen using the following CP⁰ data. 07

$$C_p^0 = a + bT + cT^2 + dT^3 \quad \text{KJ/Kmol K}$$

a	b x 10 ³	c x 10 ⁶	d x 10 ⁹
26.0257	11.7551	-2.3426	-0.5623

OR

- Q.5** (a) Discuss Proximate and Ultimate analysis of coal. 07
(b) The Orsat analysis of the flue gases from a boiler house chimney gives CO₂: 11.4%, O₂: 4.2% and N₂: 84.4% (mole%). Assuming that complete combustion takes place, 07
(a) calculate the % excess air, and
(b) find C:H ratio in the fuel.
