GUJARAT TECHNOLOGICAL UNIVERSITY BE - SEMESTER-IV • EXAMINATION – SUMMER 2013

Subject Code: 140504 Date: 17-06-2013 Subject Name: Fundamental of Chemical Engineering Calculations And Stoichiometry

Time: 10:30am – 01:00pm

Total Marks: 70

Instructions:

- 1. Attempt all questions.
- 2. Make suitable assumptions wherever necessary.
- 3. Figures to the right indicate full marks.
- **4.** Mol. Wt: Na = 23, K=39, O= 16, H=1, N=14, C=12, Mg=24, Ca=40.
- Q.1 (a) A double effect evaporator is maintained under a vacuu of 475 mm Hg. Find 04 the absolute pressure in kPa, bar and psi.
 - (b) A salt solution containing 6.5% salt by weight is mixed with pure water in a mixer to form a diluted salt solution. Sample from the dilute solution shows 0.5% salt by weight. What is ratio of flow in the two feed streams?
 - (c) A mixture of NaOH and KOH contains 56 % of NaOH. Calculate the content of 05 both components in the mixture in mol %.
- Q.2 (a) Explain the different methods of solving material balance problems without 07 chemical reactions with proper examples.
 - (b) An aqueous solution of K₂CO₃ is prepared by dissolving 45 kg K₂CO₃ in 120 kg water at 293 K. The density of the solution is measured to be 1.2 kg/L. Find the molarity, normality and molality of the solution.

OR

- (b) The analysis of a sewage gas sample from a municipal sewage treatment plant on volume basis shows 65 % Methane, 37% Carbon dioxide, 8% Ammonia and traces of H₂S, SO₂, etc. Find: i) the average molar mass of gas; and ii) the density of gas at NTP.
- Q.3 (a) Explain recycle stream, bypass stream and purge stream with a neat sketch. 07
 - (b) A fuel has the following composition by mass: C=85%, $H_2 = 14\%$ and rest noncombustibles. The fuel was completely burnt using 30% air in an internal combustion engine. Determine the exhaust gas composition.

OR

- Q.3 (a) Define: i) yield, ii) limiting component, iii) excess reactant, iv) conversion, 07 v) selectivity, vi) inert, vii) process flow sheet.
 - (b) Limestone has the following composition: CaCO₃ = 93%, MgCO₃ = 6% and 07 insoluble = 1%. 2000 kg of this limestone is calcined a lime kiln. Calculate: (i) mass of CaO formed, (ii) mass of CO₂ formed per kg of limestone.

- Q.4 (a) Differentiate between:
 - (i) Sensible heat and latent heat
 - (ii) Endothermic and exothermic reactions
 - (iii)Internal energy and external energy
 - (iv)BOD and COD.
 - (b) Pure methane is heated from 303K to 523K at atmospheric pressure. Calculate 06 the heat added per kmole methane using C_P data. $C_P = a + bT + cT^2 + dT^3$. Data for methane: a = 19.2494, $b \times 10^3 = 52.1135$, $c \times 10^6 = 11.973$, $d \times 10^9 = -11.3173$
- Q.4 (a) Define: (i) Heat of Formation (ii) Heat of Reaction (iii)Heat of Combustion (iv)Hess law.
 - (b) 200kg of solid Cadmium at 27°C is to be melted. Melting point of Cadmium is 320.9 °C. The heat is supplied by steam (latent heat = 210 kcal/kg). Find the mass of steam to be supplied. Data: At. wt of Cadmium = 112.1. Use C_p = 6 + 0.005T kcal/kmol°C where T is in °C. Latent heat of fusion of Cadmium = 2050 kcal/kmol.
- Q.5 (a) Explain distillation operation with an example.
 - (b) A pan contains 6420kg of an aqueous solution at 104°C, 29.6% of which is anhydrous sodium sulphate. The whole solution is cooled without evaporation to 20°C at which temperature crystals of Na₂SO₄.10H₂O separate out. The remaining mother liquor is found to contain 16.1% anhydrous Na₂SO₄. What is the weight of the mother liquor?

OR

- Q.5 (a) Discuss humidification operations and define some of the common 07 terminologies used for air-water operations.
 - (b) A mixture containing 47.5% acetic acid and 52.5% water (by mass) is being separated by the extraction in a counter-current multistage unit. Pure iso-propyl ether is used as an solvent. The solvent to feed ratio is 1.3. The final extraction composition on a solvent free basis is found to be 82% by mass of acetic acid. The raffinate is found to contain 14% by mass of acetic acid on a solvent free basis. Calculate the percentage of acid of the origina feed which remains unextracted.

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