

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 vacuum of 475 mm Hg. Find the absolute pressure in kPa, bar and psi. **04**
- (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? **05**
- (c) A mixture of NaOH and KOH contains 56 % of NaOH. Calculate the content of both components in the mixture in mol %. **05**
- Q.2** (a) Explain the different methods of solving material balance problems without chemical reactions with proper examples. **07**
- (b) An aqueous solution of K_2CO_3 is prepared by dissolving 45 kg K_2CO_3 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. **07**
- 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 H_2S , SO_2 , etc. Find: i) the average molar mass of gas; and ii) the density of gas at NTP. **07**
- 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 non-combustibles. The fuel was completely burnt using 30% air in an internal combustion engine. Determine the exhaust gas composition. **07**
- OR**
- Q.3** (a) Define: i) yield, ii) limiting component, iii) excess reactant, iv) conversion, v) selectivity, vi) inert, vii) process flow sheet. **07**
- (b) Limestone has the following composition: $CaCO_3$ = 93%, $MgCO_3$ = 6% and insoluble = 1%. 2000 kg of this limestone is calcined in a lime kiln. Calculate: (i) mass of CaO formed, (ii) mass of CO_2 formed per kg of limestone. **07**

- Q.4 (a)** Differentiate between: **08**
- (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 the heat added per kmole methane using C_p data. **06**
- $C_p = a + bT + cT^2 + dT^3$. Data for methane:
 $a = 19.2494$, $b \times 10^3 = 52.1135$, $c \times 10^6 = 11.973$, $d \times 10^9 = -11.3173$
- OR**
- Q.4 (a)** Define: **08**
- (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: **06**
- 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. **07**
- (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 $\text{Na}_2\text{SO}_4 \cdot 10\text{H}_2\text{O}$ separate out. The remaining mother liquor is found to contain 16.1% anhydrous Na_2SO_4 . What is the weight of the mother liquor? **07**
- OR**
- Q.5 (a)** Discuss humidification operations and define some of the common terminologies used for air-water operations. **07**
- (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 a 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 original feed which remains unextracted. **07**
