

(4)

Assume—

Solubility of the salt is 75(35°C) and heat of crystallisation of the salt is 75.2 KJ/Kg.

Specific heat of 48% salt solution is 2.97 KJ/kg K and latent heat of vaporisation of water = 2414 KJ/Kg at 35°C. 20

7. An evaporator is to be fed with 1000 Kg/hr of a solution containing 1% solute by weight at a temperature of 40°C. It is to be concentrated to a solution of 2% solute by weight in the evaporator operating at a pressure of 100 Kpa in the vapour space. The heating surface is supplied with saturated steam at 136 Kpa. Calculate the weight of the vapour produced and the weight of the steam required. If the overall heat transfer coefficient of the surface is 1400 W/m²K, calculate the necessary heating surface. Specific heat, boiling point and latent heat of the solution may be assumed to be the same as those of water. Sp heat of water is 4.19 KJ/KgK. Enthalpies of saturated vapour at 100°C and 108°C are 2675 KJ/Kg and 2690 KJ/Kg respectively. Boiling point of water at 136 Kpa is 108.4°C. 20

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Ex/FTBE/T/123/138/2012(s)

BACHELOR OF ENGINEERING (F.T.B.E.) EXAMINATION, 2012

(1st Year, 2nd Semester, Supplementary)

Chemical Engineering Fundamentals

Time : Three hours.

Full Marks : 100

Use a separate Answer-Script for each part.

PART - I

Answer any *three* questions.

1. (a) A wet food product contains 75% water. After drying, it is found that 80% of the original water has been removed. Determine (i) mass of water removed per kg of wet food and (ii) composition of wet food. 10
- (b) A liquid mixture contains three components A(MW=72), B(MW=58) and C(MW=56) in which A and B are present in the mole ratio 1.5 :1 and the weight percent of B is 25%. A sample of the mixture is found to contain 10kg of C. Calculate the total number of moles of the mixture. 10

(Turn Over)

(2)

2. In the azeotropic distillation of an ethanol-water solution, a feed mixture containing 95.6% alcohol is mixed with pure benzene and distilled the benzene forms a ternary azeotrope with alcohol-water with a composition of 74.1%, 18.5% alcohol and 7.4% water which is distilled over as the overhead product. Absolute alcohol is obtained as the bottom product. Determine the quantity of benzene required for producing 100kg of absolute alcohol. 20
3. A hydrocarbon fuel is burnt with excess air. The orsat analysis of the fine gas shows 10.2% CO₂, 1.0% CO, 8.4% O₂ and 80.4% N₂. What is the atomic ratio of H to C in the fuel? 20
4. Calculate the quantity of dry air that must be introduced into an air dryer that dries 100kg/hr of food from 80% to 5% moisture content of 0.002 kg water/kg dry air and leaves with a moisture content of 0.2 kg water/kg dry air. 20

PART - II

Answer any **two** questions.

5. (a) Define 'standard heat of formation of a compound'. What is 'Van't Hoff Box'? What reference enthalpy is the basis of steam table? 2+2+1

(3)

- (b) Calculate the heat of reaction at 1000K and 1 atm of the reaction : $H_2(g) + Cl_2(g) \rightarrow HCl(g)$

Assume,

$$\bar{C}_{P(H_2 \text{ at } 1000K)} = 29.46 \text{ KJ / Kmol.K}$$

$$C_{P(Cl_2 \text{ at } 1000K)} = 36.45 \text{ KJ / Kmol.K}$$

$$\Delta H^\circ_f(HCl) = - 92.300 \text{ KJ / Kmol}$$

$$\bar{C}_{p(HCl)} = - 30 \text{ KJ / Kmol.K} \quad 10$$

- (c) When a system is taken from a state (i) to state (ii) along a certain path, 100J of heat flows into the system and the system does 40J of work. How much heat flows into the system if the work done by the system is 20J during same change of state but along a different path? The system returns to 'b' to 'a' along a third path. If the work done on the system is 30J does the system absorb or liberate heat? If yes, by how much? 5

6. Ammonium sulphate is to be crystallised from a solution containing 48% of the salt by cooling in a counter flow crystalliser from 85°C to 35°C. During cooling the amount of water that evaporates is 5% of the mass of feed solution. If the feed rate is 1000 kg/hr, calculate—
- (i) the rate of formation of crystals.
- (ii) the cooling surface required, if overall heat transfer coefficient is 125 W/m²K and temperature rise of cooling water is 18 to 29°C,

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