Seat No.: _____   Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY
BE - SEMESTER–IV • EXAMINATION – WINTER • 2014

Subject Code: 140504   **Date: 02-01-2015**
Subject Name: Fundamental of Chemical Engineering Calculations And Stoichiometry
Time: 02:30 pm - 05:00 pm   **Total Marks: 70**
Instructions:
1. **Attempt all questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Figures to the right indicate full marks.**

Q.1	(a)	Define the following terms: (1) Yield (2) Dew point (3) Latent heat (4) Dry-bulb temperature (5) Absolute humidity (6) Wet bulb temperature (7) Limiting component	07
	(b)	(1) Convert the heat transfer coefficient of value 100 Btu/ hr. ft^2. ^{0}F into W/ m^2. ^{0}C.	04
		(2) Iron metal weighs 500 lb and occupies a volume of 29.25 litres. Find the density in Kg/ m^3.	03
Q.2	(a)	A solution of NaCl in water contains 30% NaCl (by mass) at 65^0C. The density of the solution is 1.25 Kg/ lit. Find the molarity, normality and molality of solution.	07
	(b)	Sodium chloride weighing 600 Kg is mixed with 200 Kg of Potassium Chloride. Find the composition of mixture in (i) mass % and (ii) mole %.	07

OR

	(b)	A mixture of gases is obtained having following % composition by weight. The composition is chlorine (Cl_2) = 67, bromine (Br_2) = 28 and oxygen (O_2) = 5. Using the ideal gas law, calculate (i) composition of the gas by volume and (ii) density of the mixture in gm/ litre at 25^0 C and 740 mm Hg pressure. Take atomic weights of Cl, Br and O are 35.5, 80 and 16 respectively	07
Q.3	(a)	Cracked gas from petroleum refinery has following composition by volume: 45% methane, 10 % ethane, 25% ethylene, 7% propane, 8% propylene and 5% n - butane. Find (i) the average molar mass of the gas mixture (ii) the composition by mass and (iii) specific gravity of the gas mixture.	07
	(b)	What is material balance? What is process flow chart? Explain importance of process flow chart in chemical industry.	07

OR

Q.3	(a)	The spent acid from a nitrating process contains 33% sulphuric acid, 36% nitric acid and 31% water by weight. This acid is to be strengthened by the addition of concentrated sulphuric acid containing 95% H_2SO_4 and concentrated HNO_3 containing 78% HNO_3. The strengthened mixed acid is to contain 40% H_2SO_4 and 43% HNO_3. Calculate the quantities of spent acid and concentrated acids that should be mixed together to yield 1500 Kg of the desired mixed acid.	07
	(b)	Explain recycling and bypassing with reference to chemical industry with suitable diagram.	07
Q.4	(a)	A solution contains 50% benzene, 30% toluene and 20% xylene by weight at temperature of 100^0 C. The vapours are in contact with the solution. Calculate the total pressure and the molar % compositions of liquid and the vapour. The vapour pressure data for different components at 100^0 C are as follows:	07

Component	Benzene	Toluene	Xylene
Vapour press., mm of Hg	1340	560	210

	(b)	Define the following unit operations with suitable diagram and example: Distillation, Absorption, Extraction, Crystallization and Evaporation.	07

OR

Q. 4 (a) (1) A compound whose molecular weight is 103 analyses C - 81.5; H – 4.9; N – 13.6. What is the formula of compound? 04

(2) A solution of naphthalene ($C_{10}H_8$) in benzene contains 25 mole %. Express the composition of mixture in weight %. 03

(b) The feed to a fractionating system is 30,000 Kg/ hr of 50% benzene, 30% toluene and 20% xylene. The fractionating system consists of two towers no.1 and no.2. The feed enters tower 1. The overhead product from 1 is X Kg/ hr of 95% benzene, 3% toluene and 2% xylene. The bottom product from 1 is feed to 2 resulting in an overhead product of Y Kg/ hr of 3% benzene, 95% toluene and 2% xylene while the bottom from tower 2 is Z Kg/ hr of 1% benzene, 4% toluene and 95% xylene. Find X, Y and Z? 07

Q.5 (a) A solution of Potassium dichromate in water contains 13% $K_2Cr_2O_7$ by weight. 1000 Kg of this solution is evaporated to remove some amount of water. The remaining solution is cooled to 20^0 C. If the yield of $K_2Cr_2O_7$ is 80%. Calculate the amount of water evaporated. Solubility of $K_2Cr_2O_7$ is 0.39 Kg mole per 1000 Kg water at 20^0 C. Take atomic weights of K and Cr is 39 and 52 respectively. 07

(b) A distillation column separates 10, 000 Kg/ hr of 50% benzene and 50% toluene. The product recovered from the top contains 95% benzene while the bottom product contains 96% toluene. The stream entering the condenser from top of the column is 8000 Kg/ hr. A portion of the product is returned to column as reflux and the remaining withdrawn as top product. Find the ratio of the amount refluxed to the product. 07

OR

Q.5 (a) Define sensible heat, latent heat, heat of formation, heat of combustion and standard heat of reaction. 07

(b) In crystallization process a solution of $CaCl_2$ in water contains 62 parts of $CaCl_2$ per 100 parts of water. Calculate the weight of solution necessary to dissolve 250 Kg $CaCl_2.6H_2O$ crystal at temperature of 25^0C. Solubility of $CaCl_2$ at 25^0C is 7.38 Kg mole of $CaCl_2$ per 1000 Kg of H_2O. 07

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