Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

BE - SEMESTER–III • EXAMINATION – WINTER • 2014

Subject Code: 2130504 Date: 30-12-2014

Subject Name: Process Calculation

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.**
4. **Atomic weights: C:12, H:1,O:16, S:32, Cl:35.5, Na:23,N:14,Mg:24,B:11,Si:28,Al:27,Fe:56,Zn:65**

Q.1 **(a)** (i) The diameter and hieght of a vertical cylindrical tank are 5 ft and 6ft respectively. It is full up to 65% hieght with carbon tetrachloride (CCl_4), the density of which is 1.6 kg/L. Find the mass in Kilograms. **04**

(ii) Convert: (a) 2.1gm/cm^3 to lb/ft^3 (b) 550 kPa to Torr (c) 700^{o}R to ^{o}F **03**

(b) A gas mixture has the following composition by volume: SO_2-8.5%,O_2-10 % and rest is nitrogen.Find (1) the avg. Molar mass of the gas mixture, (2) the composition by mass, and (3) the density of the mixture in kg/m^3 at 473 K and 202.65 kPa gauge. **07**

Q.2 **(a)** An aqueous soution of acetic acid of 35% concentration (by mass) has a density of 1.04 kg/L at 25^{o}C. Find the molarity, Normality and Molality of the solution. **07**

(b) The analysis of a sample of glass yields 7.8% Na_2O, 7.0% MgO, 9.7% ZnO, 2.0% Al_2O_3, 8.5% B_2O_3 and 65.0% SiO_2 (by mass). Convert this composition into mole%. **07**

OR

(b) A waste acid from nitrating process contains 20% HNO_3, 40% H_2SO_4, and 40% water by weight. This acid is concentrated to contain 40% HNO_3, 50 % H_2SO_4 by the addition of concentrated H_2SO_4 containing 99% H_2SO_4 and concentratd Nitric acid containing 95% HNO_3. Calculate the weight of waste and concentrated acid that must be obtaining 1000 kg of desired mixture. **07**

Q.3 **(a)** An aqueous solution of pyridine containg 27% (by wt.) pyridine and 73% (by wt.) water is to be extracted with chloro-Benzene. The feed and solvent are mixed well in batch extractor and the mixture is then allowed to stand for phase separation. The exract phase conains 11% pyridine, 88.1%chlorobenzene and 0.9% water b weight. The raffinate phase contains 5% pyridine and 95% water by weight. Calculate: (1) The quantities of two phases (2) The weight ratio of solvent to feed based on 100 kg of feed. **07**

(b) The feed to acontinous fractionating column analysed by weight 28% benzene and 72% toluene. The analysis of the distilate shows 52 % (by weight) benzene and 5 % (by weight) benzene was found in the bottom product.Calculate the amount of distillate and bottomproduct per 1000 kg of feed per hour. Aslo calculate the percent recovery of benzene. **07**

OR

Q.3 **(a)** 2000 kg of wet solids containing 70% solids by weight are fed to tray dyer where it is dried by hot air. The product finally obtained is found to contain 1% moisture by weight, calculate: (1) kg of water removed from wet solids (2) kg of the product obtained. **07**

(b) Discuss about recycling and By passing operations. **07**

Q.4 **(a)** In the Decon process for the manufacture of chlorine, a dry mixture of hydrochloric acid gas and air is passes over a heated catalyst which promotes oxidation of acid. Air is used in 30% excess of htat theoritically require. Calculate the weight of air supplied per kilogram of acid. **07**

(b) A solution of ferric chloride in water contains 64% $FeCl_3$ by weight. Calculate the amount of $FeCl_3.6H_2O$ which will crystallise at 300 K from 1000 kg of feed solution. The solubility of $FeCl_3$ at 300 K is 68.3% by weight $FeCl_3$. **07**

OR

Q.4 **(a)** Gaseous benzene reacts with hydrogen in presence of Ni catalyst as: **08**
C_6H_6 (g) $+3H_2$ (g) ------- C_6H_{12} (g). 30%excess hydrogen is used above that required by above reaction. Conversion is 50% and yield is 90%. Calculate the requirement of benzene and hydrogen gas for 100 moles of cyclohexane.

(b) Define: (1) Heat of reaction (2) Heat of combustion (3) Std. heat of formation (4) Heat capcity. **06**

Q.5 **(a)** Flue gas leaving the boiler stack at 523 K has following composition on mole basis CO_2- 11.31%, H_2O-13.04%, O_2-2.17% and N_2-73.48%. Calculate the heat lost in 1 kmol of gas mixture above 298 K using heat capacity data given below $C_p= a+bT+cT^2+dT^3$ in kJ/kmol K. **08**

Gas	**a**	**b*10^3**	**c*10^6**	**d*10^9**
CO_2	21.3655	64.2841	-41.0506	9.7999
H_2O	32.4921	0.0796	13.2107	-4.5474
N_2	29.5909	-5.141	13.1829	-4.968
O_2	26.0257	11.7551	-2.3426	-0.5623

(b) (i) Calculate the heat of formation of glycerol liquid ($C_3H_8O_3$) at 298 K from its elements using Hess's law. Data: Heat of foramtion of $CO_{2\ (g)}$ = (-393.51 kJ/mol), Heat of formation of $H_2O_{\ (l)}$ = (-285.83 kJ/mol), Heat of combustion of glycerol liquid at 298 K= (-1659.10 kJ/mol). **03**

(ii) Calcuate the standard heat of reaction of the following reaction and also suggests weather reation is (Exothermic/Endothermic). **03**
$(COOH)_{2(s)}$ -------- $HCOOH_{(l)} + CO_{2\ (g)}$. using following Data:

Component	**ΔH^o_c, kJ/mol at 298K**
$(COOH)_{2(s)}$	-244.76
$HCOOH_{(l)}$	-254.64

OR

Q.5 **(a)** Discuss proximate analysis and ultimate analysis of coal. **07**

(b) The orsat analysis of the flue gases by mole is as given below: CO_2-11.4%, O_2-4.2% and N_2-84.4%. Assuming that complete combustion takes place. Calculate (1) the % excess air (2) find the C: H ratio in the fuel. **07**

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