SE Sem III (Chem) CBSGS 10/12/13

PC

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**Con. 8943–13.**

Process Calculations

**GX–12164**

(3 Hours) 26

**[ Total Marks : 80**

**N. B. :** (1) Question No. **1** is **compulsory**.
(2) Solve any **three** questions out of remaining **five** questions.
(3) Assume **suitable** data if **required** and justify the **same**.

1. (a) Explain general material balancing procedure for a material balance problem. 5
(b) Define normality, molarity, molality, gram equivalents. 4
(c) Explain the meaning of limiting reactant and excess reactant. 4
(d) Explain Hess's law of constant heat summation with suitable example. 7

2. (a) By electrolyzing a mixed brine a mixture of gases is obtained at cathode having the following composition by weight. 10

$Cl_2$ – 67 %
$Br_2$ – 28 %
$O_2$ – 5 %

Using ideal gas law calculate :–
(i) Composition of the gas by volume
(ii) Density the gas mixture per litre at 25°C and 740 mm Hg.

(b) A solution contains 55% benzene, 35% toluene and 10% xylene by weight at a temperature of 100°C. The vapours are in contact with solution. Calculate the total pressure and the molar percentage compositions of liquid and the vapour. The vapour pressure and molecular weights are as follows :– 10

| Component | Vapour pressure at 20°C | mol.wt. |
|---|---|---|
| Benzene | 1340 mm of Hg | 78 |
| Toluene | 560 mm of Hg | 92 |
| Xylene | 210 mm of Hg | 106 |

3. (a) The spent acid contains 33% $H_2SO_4$, 40% $HNO_3$ and rest water. This acid is to be strengthened by addition of concentrated sulphuric acid containing 96% $H_2SO_4$ and concentrated nitric acid containing 79% $HNO_3$. The strengthened mixed acid is to contain 43% $H_2SO_4$ and 40% ~~$NHO_3$~~ $HNO_3$. Calculate the quantities of spent and concentrated acids that should be mixed together to yield 1500 kg of desired mixed acid. 10

(b) 4000 kg of KCl are present in a saturated solution at a temperature of 80°C. The solution is cooled to 20°C in an open tank. The solubilities of KCl and 80°C and 20°C are 55 parts and 35 parts per 100 of water respectively. 10

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**Calculate –**

(i) Assume water equal to 3% of solution by weight is lost by evaporation, weight of crystals obtained.

(ii) The yield of crystals neglecting loss of evaporation.

4. (a) A limestone has the following composition. 12

$CaCO_3$ – 93%, $MgCO_3$ – 6% and in solubles – 1%

**Calculate –**

(i) How many kgs of CaO will be obtained from 2000 kg of limestone ?

(ii) Kg of $CO_2$ available per kg limeotone.

(iii) Kg of limestone required for the manufacture of 1000 kg of CaO.

(b) Explain the following :– 8

(i) Recyle

(ii) Bypass

(iii) Purge

(iv) Standard heat of reaction.

5. (a) Explain, how would you calculate heat of reaction from heat of formation and heat of combustion data for reactants and products. 4

(b) Explain the term "adiabatic reaction temperature". 4

(c) On the basis of the data and chemical reactions below find heat of formation of Zn $SO_4$ form its elements :– 12

(i) $Zn + S \text{ (rhomb.)} \rightarrow ZnS, \Delta H = -44 \frac{\text{k cal}}{\text{k mol}}$

(ii) $'2' ZnS + 3O_2 \rightarrow '2' ZnO + '2' SO_2, \Delta H = -221 \cdot 88 \frac{\text{k cal}}{\text{k mol}}$

(iii) $'2' SO_2 + O_2 \rightarrow '2' SO_3, \Delta H = -46 \cdot 88 \frac{\text{k cal}}{\text{k mol}}$

(iv) $ZnO + SO_3 \rightarrow ZnSO_4, \Delta H = -55 \cdot 10 \frac{\text{k cal}}{\text{k mol}}$.

6. (a) Explain in detail, what you mean by humidification and dehumidification. 5

(b) Define – 6

molal. (i) Absolute humidity

(ii) Metal humidity

(iii) Percentage saturation.

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(c) Calculate the number of kilocalories required to heat from 500°K to 1500°K, / 9
$m^3$ of gas measured at 1 atm and 0°C having following composition by volume.

$CO_2 = 70\%$
$N_2 = 27\%$
$O_2 = 2\%$
$H_2 = 1\%$.

Specific heat $Cp = a + bT + CT^2 \frac{kcal}{kmol°k}$

**Data –**

| | | | |
|---|---|---|---|
| $CO_2$ | $a = 6{\cdot}339$ | $b = 10{\cdot}14 \times 10^{-3}$ | $c = -3{\cdot}415 \times 10^{-6}$ |
| $N_2$ | $a = 6{\cdot}457$ | $b = 1{\cdot}389 \times 10^{-3}$ | $c = -0{\cdot}069 \times 10^{-6}$ |
| $O_2$ | $a = 6{\cdot}117$ | $b = 3{\cdot}167 \times 10^{-3}$ | $c = -1{\cdot}005 \times 10^{-6}$ |
| $H_2$ | $a = 6{\cdot}946$ | $b = -0{\cdot}196 \times 10^{-3}$ | $c = 0{\cdot}4757 \times 10^{-6}$ |

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