BT / III / CBGS / Process Calcu

(7)

(23)

QP Code : 4953

(3 Hours) [Total marks: 80]

N.B: (1) Question No. 1 is compulsory

(2) Attempt any three of remaining five questions

(3) Assume suitable data wherever necessary

1. (a) Define the following (Any four) (10)
   i. Molarity
   ii. Stoichiometry
   iii. Stoichiometric ratio
   iv. Limiting reagent
   v. Percentage excess

   (b) Prove for an ideal gas: Pressure% = Mole% = Volume % (10)

2. (a) Write an outline of procedure for material balance calculations (12)

   (b) How many moles of H_2SO_4 will contain 64 kg of S? (04)

   (c) Convert 294 g/L H_2SO_4 to normality (04)

3. (a) 1000 kg/h of a mixture containing equal parts by mass of benzene and toluene are distilled to get overhead product containing 95% benzene (weight basis). The flow rate of bottom stream being 512 kg/h. (12)
   Calculate:
   i. The percentage of toluene in the bottom product (weight basis)
   ii. Flow rate of overhead product and its molar composition
   iii. Molar percentage of benzene in the feed

   Molecular weight of benzene: 78
   Molecular weight of Toluene: 92

   (b) 98 grams of sulphuric acid (H_2SO_4) are dissolved in water to prepare one liter if solution. Find normality and molarity of the solution. (05)

   (c) Find out grams of HCl needed to prepare 2 L 2N HCl solution. (03)

(P. T. O.)

11.6.15

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4. (a) A coke is known to contain 90% carbon and 10% non-combustible ash (by weight): (12)

I. How many moles of oxygen are theoretically required to burn 100 kg of coke completely?

II. If 50% excess air is supplied, calculate the analysis of gases at the end of combustion?

(b) Ammonia is produced by the following reaction: (08)

$N_2 + 3H_2 \rightarrow 2NH_3$

Calculate:

I. The molal flow rate of hydrogen corresponding to N2 feed rate of 25 kmol/h if they are fed in the stoichiometric proportion

II. The kg of ammonia produced per hour if percent conversion is 25 and nitrogen feed rate is 25 kmol/h

5. (a) A natural gas has the following composition on mole basis: (12)
$CH_4 = 84\%$, $C_2H_6 = 13\%$, $N_2 = 3\%$. Calculate the heat to be added to 10 kmol of natural gas from 298 to 523 K using the heat capacity data given below.
$C_p^0 = a + bT + cT^2 + dT^3$ kJ/(kmol.k)

Gas	a	$b*10^3$	$c*10^6$	$d*10^9$
CH_4	19.2494	52.1135	11.973	-11.3173
C_2H_6	5.4129	178.0872	-67.3749	8.7147
N_2	29.5909	-5.141	13.1822	-4.968

(b) Calculate the standard heat of formation of chloroform gas from its elements using Hess's law (08)

$C_{(s)} + O_{2(g)} \rightarrow CO_{2(g)}$, $\Delta H_1 = -393.51$ kJ/mol
$H_{2(g)} + \frac{1}{2}O_{2(g)} \rightarrow H_2O_{(l)}$, $\Delta H_2 = -285.83$ kJ/mol
$1/2H_{2(g)} + \frac{1}{2}Cl_{2(g)} \rightarrow HCl_{(aq)}$, $\Delta H_3 = -167.57$ kJ/mol
$CHCl_{3(g)} + \frac{1}{2}O_{2(g)} + H_2O(l) \rightarrow CO_{2(g)} + 3HCl_{(aq)}$, $\Delta H_4 = -509.95$ kJ/mol

6. Write short notes on any four (20)

(a) Liquid-Liquid extraction

(b) Drying

(c) Distillation

(d) Evaporation

(e) Ideal gas law