B.E. (Chem) – Sem III – CBSGS – P.C

Process Calculations.

08 DEC 2014 **QP Code :14656**

28

(3 Hours) **[Total Marks : 80**

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

1. (a) Define :— Normality, Molarity, Molality, Equivalent weight of an element or compound, Gram equivalent. **5**
(b) Explain the terms limiting reactant and excess reactant. **5**
(c) How you will calculate standard heat of reaction from heat of combustion. **5**
(d) Define the terms :— Gross calorific value and Net calorific value. **5**

2. (a) An inert gas (molecular weight 28) is admitted at the rate of 1 m^3/min at 202.65 kPa and 303°K to a pipeline in which natural gas is flowing. The analysis of this gas at a very long distance shown 2.9 percent by volume inert gas. Calculate the flow rate of natural gas through the pipeline per minute at 101.325 kPa and 303°K. **15**
(b) A solution contain 55% benzene, 28% toluene and 17% xylene by weight, Calculate the molar composition of the liquid. **5**

3. (a) Explain material balance equation with block diagram for following unit operations.
(i) Distillation (ii) Extraction. **10**
(b) 2000 kg of wet solid containing 70 percent solids by weight are fed to a tray dryer where it is dried by hot air. The product finally obtained is found to contain 1 percent moisture by weight. **10**
Calculate :— (i) The kg of water removed from wet solids.
(ii) The kg of product obtained.

4. (a) Ethylene oxide is produced by oxidation of ethylene 100 Kmol of ethylene are fed to a reactor and the product is found to contain 80 Kmol ethylene oxide and 10 Kmol CO_2. Calculate :— **10**
(i) The percent conversion of ethylene.
(ii) Percent yield of ethylene oxide.

$$\text{Reaction} :- C_2H_4 + \frac{1}{2}O_2 \rightarrow C_2H_4O$$

$$C_2H_4 + 3O_2 \rightarrow 2CO_2 + 2H_2O$$

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(b) The carbon monoxide is reacted with hydrogen to produce methanol. Calculate from the reaction :— 10

(i) Stoichiometric ratio of H_2 to CO

(ii) Kmol of CH_3OH produced per kmol CO reacted

(iii) The weight ratio of CO to H_2 if both are fed to reactor in stoichiometric proportion.

(iv) The quantity of CO required to produce 1000kg of CH_3OH.

5. (a) A stream of nitrogen flowing at a rate of 100 kmol/h is heated form 303K to 373K. Calculate the heat that must be transferred. 10

C_p^0 for nitrogen $= 29.5909 - 5.141\times10^{-3}T + 11.1829\times10^{-6}T^2 - 4.968\times10^{-9}T^3$

(b) Calculate heat of, formation of ethane gas at 298°K from its elements using Hess's law. 10

Data :— Heat of formation of $CO_{2(g)} = -393.51\frac{KJ}{mol}$

Heat of formation of $H_2O_{(l)} = -285.83\frac{KJ}{mol}$

Heat of combustion of ethane gas at $298K = -1560.69\frac{KJ}{mol}$

6. (a) Define :— 5

(i) Dry bulb temperature

(ii) Wet bulb temperature

(iii) Absolute humidity

(iv) Molal humidity

(v) Relative humidity.

(b) Air has a percentage humidity of 60 at a temperature of 300K and a pressure of 100kPa. Calculate the pressure to which air must be compressed at a constant temperature so as to remove 90% of the water present. Vapour pressure of water at 300K = 3.565kPa. 10

(c) Crude oil analysed to contain 87 percent carbon, 12.5 percent hydrogen and 0.5 percent sulphur by weight. Calculate the net calorific value of crude oil at 298 K. Gross calorific value of crude oil at 298 K = 45071 KJ/kg oil, latent heat of water vapour at 298 K = 2442.5 KJ/kg. 5