June 14, 2024 02:30 pm - 05:30 pm 1T00533 - S.E.(Chemical Engineering)(SEM-III) (Choice Base Credit Grading System) (R- 19) (C Scheme) / 50725 - Process Calculations
QP CODE: 10041222

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

N.B. (i) Question number 1 is compulsory.
(ii) Answer any three questions from rest.
(iii) Assume suitable data wherever necessary.

Q.1 a) Define Normality and Molality [5 marks]

b) The ground nut seeds containing 45% oil and 45% solids are fed to expeller, the cake coming out of expeller is found to contain 80% solids and 5% oil. Find the percentage recovery of oil. [5 marks]

c) Explain limiting and excess reactant in detail. [5 marks]

d) What do you mean by Recyle, Bypass and Purge operations, explain in detail. [5 marks]

Q.2 a) A feed to a continuous fractionating column analyses 28% Benzene and 72% toluene by weight. The analysis of the distillate shows that 52 weight % Benzene and 5 weight % Benzene was found in the bottom product. Calculate the amount of distillate and bottom product per 1000 kg of feed per hour. Also Calculate the % recovery of Benzene. [10 marks]

b) A dryer is fed with wet solids to reduce the moisture content from 80% to 15%. The product leaving the dryer is admitted in to an oven which further brings down the moisture to 2%. If the dryer can handle 1000 kg of wet solids per day. Calculate [10 marks]

i. The weight of products leaving the dryer and oven per day.
ii. The percentage of the original water that is removed in the dryer and oven.

Q.3 a) A feed containing 60 mole% A, 30 mole% B and 10 mole% inerts enters a reactor. 80 % of original A reacts according to the following reaction [10 marks]

$2A + B \longrightarrow C$

Find the composition of the product stream on mole basis.

b) A combustion chamber is fed with 50 kmol/h of butane and 2000 kmol/h of air. Calculate the % excess air used and composition of the gases leaving combustion reactor assuming complete combustion of butane. [10 marks]

Q.4 a) A vapour at 411 K and Standard atmospheric pressure, containing 0.72 mole fractions Benzene and 0.28 mole fractions Toluene serve as a feed to a fractionating column in which it is separated into a distillate containing 0.995 mole fraction Benzene and bottoms with 0.97 mole fraction Toluene. The reflux ratio is desired to be 1.95 kmol/kmol of distillate product. For a feed of 100 kmol, compute the overall material and energy balances. Assume that there is no heat loss to the surrounding and the heat of solution is negligible. [14 marks]

Enthalpy of Vapours (overhead) = 42,170 kJ/kmol mixture
Enthalpy of liquid (overhead) = 11,370 kJ/kmol mixture
Specific enthalpy of bottom product = 18,780 kJ/kmol mixture
Enthalpy of feed = 44,500 kJ/kmol

b) In the given reaction, the per pass conversion is 67%. The product leaving the reactor is fed to a separation unit battery where formaldehyde is separated from methanol and hydrogen. The separated methanol is recycled to the reactor. [6 marks]

$CH_3OH \longrightarrow HCHO + H_2$

If the production rate of formaldehyde is 1000 kg/h.
Calculate

1. The combined feed ratio
2. The flow rate of methanol required to the process as fresh feed

Q.5 a) Heat capacity data for gaseous SO_2 is given by the following equation [10 marks]

$$C_P^0 = 43.458 + 10.634 \times 10^{-3}\, T - 5.945 \times \frac{10^5}{T^2}$$

Calculate the heat that must be needed to raise the temperature of 1 kmol of pure SO_2 from 300 K to 1000 K.

b) Natural gas is piped from the well at 300 K and 400 kPa. The gas is found to contain 93% Methane, 4.5 % Ethane and the rest Nitrogen. Calculate the following, [10 marks]

1. The partial pressure of Nitrogen.
2. The pure component volume of ethane in 10 m^3 of the gas.
3. The density of the gas as piped in kg/m^3.
4. The average molecular weight of gas.

Q.6 Attempt any four from the following [20 marks]

a) Prove mole % = Volume %

b) Calculate the standard heat of reaction of the following reaction

$(COOH)_{2(s)} \longrightarrow HCOOH_{(l)} + CO_{2(g)}$

Component	ΔH_c^0, kJ/mol
$(COOH)_{2(s)}$	-244.76
$HCOOH_{(l)}$	-254.64

c) Calculate the standard heat of formation of n-propanol liquid using following data:
Standard heat of formation of $CO_{2(g)}$ = -393.51 kJ/mol
Standard heat of formation of $H_2O_{(l)}$ = -285.83 kJ/mol
Standard heat of combustion of n-propanol liquid = -2028.19 kJ/mol

d) Explain Hess's Law and latent heat in detail.

e) 20g of caustic soda is dissolved in water to prepare 500ml of solution. Find normality and molarity of solution.

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