CBCS SCHEME

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18BT41

Fourth Semester B.E. Degree Examination, June/July 2024
Stoichiometry

Time: 3 hrs. Max. Marks: 100

Note: ***Answer any FIVE full questions, choosing ONE full question from each module.***

Module-1

1 a. Define Normality , Molarity , Molality PPM and Mol %. **(10 Marks)**

b. A mixture of CH_4 and C_2H_6 has a density of 1kg/m^3 at 273K and 101.325 kPa. Calculate the mol% and weight % of CH_4 and C_2H_6 in the mixture. **(10 Marks)**

OR

2 a. Explain Amagatz law and Dalton's law for an ideal gas. Prove that pressure % = mol % = volume %. **(10 Marks)**

b. An aqueous solution of K_2CO_3 is prepared by dissolving 43kg of K_2CO_3 in 100kg of water at 293K. Find Molarity , Normality and Molality of solution. Take density of solution is 1.3kg/lit. **(10 Marks)**

Module-2

3 a. A feed containing 50% benzene and 50% Toluene is fed to the distillation column at the rate of 5000kg/hr. Top product containing 95% of benzene of bottom product containing 92% Toluene on a weight basis. Calculate the mass flow rate of the distillate and residue. Also find the % recovery of benzene. **(10 Marks)**

b. An aqueous solution of $Na_2 SO_4$ is saturated at 35°C. Calculate the solute crystallized as $Na_2SO_4CO\ H_2O$ if it is cooled to 27°C. The solubility of salt at 27 °C is 23.3% and at 35°C is 32.5%. **(10 Marks)**

OR

4 a. A dryer system handles 2500kg/day of wet solids containing 50% solids and 50% moisture are fed to the first dryer. From the first dryer the product comes out has 20% moisture, which is admitted to the 2nd drier from when the product comes out has 2% moisture. Calculate the % of original moisture removed in each drier and find the final weight of product. **(10 Marks)**

b. Soya bean seeds are extracted with hexane (solvent) in a batch extractor. If the flaked seeds contain 18.6% oil , 69% solids and rest moisture. At the end of extraction , deoiled cake is separated from the hexane oil mixture. Deoiled cake analysis yields 0.8% oil and 81.7% solids and rest moisture. Find the % recovery of oil. **(10 Marks)**

Module-3

5 a. It is required to make 24% solution by weight of NaOH for the purpose of maintaining pH in a process. Due to very high heat of dissolution it is prepared by 2 step process as shown in Fig. Q5(a). To get 100kg/hr of 24% NaOH solution how much solid NaOH required and how much water to be bypassed per hour. **(10 Marks)**

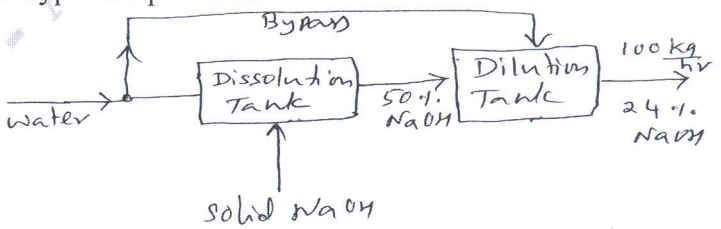

Fig. Q5(a)

b. Explain the following : i) Limiting reactant ii) Excess reactant iii) Conversion iv) Yield v) % Excess. **(10 Marks)**

OR

6 a. A combustion reactor is fed with 50 Kmp/hr of butane and 2000 Kmol/hr of air. Calculate the % excess air used and composition of gases leaving combustion reactor assuming complete combustion of butane. **(10 Marks)**

b. Phenol is produced by reaction of chlorobenzene with sodium hydroxide according to the reaction given below :

$C_6H_5C\ell + NaOH \rightarrow C_6H_5OH + NaC\ell$.

In a particular batch operation , 1320 kg of chlorobenzene is mixed with 1200kg of NaOH solids to produce 1000kg of Phenol. Identify the excess reactant and find % excess and yield of phenol produced. **(10 Marks)**

Module-4

7 a. Explain the following : i) Heat of reaction ii) Heat of combustion iii) Heat of formation iv) Standard heat of formation. **(10 Marks)**

b. A stream of CO_2 at a flow rate of 100kmol/min is heated from 298K to 383K. Calculate the heat that must be transferred using the following C_p data. (kJ/Kmol.K).

$C_p = 21.3655 + 64.284 \times 10^{-3}T - 41.0506 \times 10^{-6}T^2 + 9.799 \times 10^{-9}T^3$. **(10 Marks)**

OR

8 a. Calculate the heat of formation of propanol liquid using the following data :

Data : ΔH_f of $CO_2 = -393.51$ kJ/mol.

ΔH_f of $H_2O = -285.83$ kJ/mol.

ΔH_c of $C_3H_7OH = -2028$ kJ/mol. **(08 Marks)**

b. Calculate the heat of reaction at 773K and 1.013 bar for the following reaction.

$CO_2 + 4H_2 \rightarrow CH_4 + 2H_2O$

Data : ΔH_f at 298K [kJ/mol] ; $CO_2 = -393.65$; $H_2O = -241.9$; $CH_4 = -74.89$

Specific heat Cp data : (J/mol.K)

C_p of $CO_2 = 26.75 + 42.26 \times 10^{-3}\ T - 14.25 \times 10^{-6}\ T^2$.

C_p of $H_2O = 26.88 + 4.35 \times 10^{-3}\ T - 0.33 \times 10^{-6}\ T^2$

C_p of $CH_4 = 13.41 + 77.03 \times 10^{-3}\ T - 18.74 \times 10^{-6}\ T^2$.

C_p of $H_2 = 26.89 + 4.38 \times 10^{-3}\ T - 0.3265 \times 10^{-6}\ T^2$. **(12 Marks)**

Module-5

9 a. Give an overview of traditional and modern application of biotechnological processes. **(06 Marks)**

b. Explain the manufacture of penicillin with a neat sketch and define the various unit operation involved. **(14 Marks)**

OR

10 a. With a neat diagram, describe a typical biological process emphasizing on upstream and downstream technology. **(12 Marks)**

b. Explain the general material balance for steady state and unsteady state operations. **(08 Marks)**

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