CBCS SCHEME

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18BT41

Fourth Semester B.E. Degree Examination, Dec.2023/Jan.2024
Stoichiometry

Time: 3 hrs. Max. Marks: 100

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

Important Note : 1. On completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages.
2. Any revealing of identification, appeal to evaluator and /or equations written eg, 42+8 = 50, will be treated as malpractice.

Module-1

1 a. Write a note on general material balance equation. How does it simplify to a steady state process? **(04 Marks)**

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

c. A sample of caustic soda flakes containing 74.6% Na_2O (by weight). Find the purity of flakes. **(06 Marks)**

OR

2 a. A solution of NaOH contains 20% NaOH by weight. The density of solution is 1.196 kg/lit. Find the normality, molarity and molality. **(10 Marks)**

b. Define Amagatz law and Dalton's law and for an ideal gas mixture prove that mol% = volume% = pressure%. **(10 Marks)**

Module-2

3 a. A tank of weak battery acid contains 12.43% H_2SO_4. If 200 kg of 77.7% H_2SO_4 is added to the tank and the final solution contains 18.63% H_2SO_4. How many kgs of battery acid have been made? **(08 Marks)**

b. 1 ton of 20% solution of salt is concentrated to saturation at 100°C. The solution is then cooled to 25°C and salt crystals formed are removed by filtration. To each kg of crystals 0.15 kg of solution adhers. When the crystals are dried the salt in the adhering solution is deposited on the crystals. Calculate the total weight of salt obtained and the amount of water evaporated to achieve saturation at 100°C.

Data:

Temperature (°C)	Solubility (kg/kg of water)
100	1.8
25	0.72

(12 Marks)

OR

4 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 of NaOH in water, it is prepared by 2 step process as shown in the Fig.Q4(a). To get 100 kg/hr of 24% solution, how much solid NaOH required and how much water to be bypassed/hr?

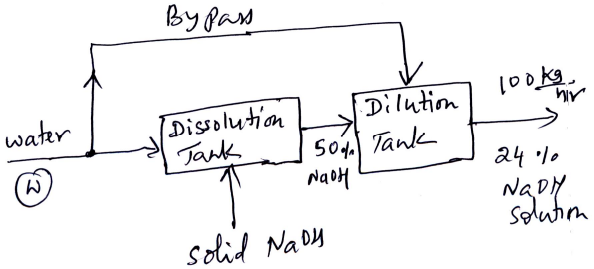

Fig.Q4(a) **(10 Marks)**

b. List and explain the different types of fuels. **(06 Marks)**

c. Write notes on the following:
(i) Ultimate analysis
(ii) Proximate analysis **(04 Marks)**

Module-3

5 a. An inspector files a report against a factory owner charging the contents in the gases of chimney is well above the dangerous level of 15% and against the city court. The factory owner burns a natural gas containing 100% methane and 130% excess air. Is the inspector's charge is sustainable? **(10 Marks)**

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

OR

6 a. Phenol is produced by reduction of chlorobenzene with NaOH according to the reaction, $C_6H_5C\ell + NaOH \rightarrow C_6H_5OH + NaC\ell$. In a particular batch operation 1320 kg of chlorobenze is mixed with 1200 kg of NaOH solids to produce 1000 kg of phenol. Identify the excess reactant and determine % excess and % yield of phenol obtained. **(10 Marks)**

b. With the help of suitable flow chart, explain the following:
(i) Recycle (ii) Bypass (iii) Purging **(06 Marks)**

c. Production of SO_3 requires 100 Kmoles of SO_2 and 200 Kmoles of O_2 which are fed to the reactor. The product stream was found to contain 80 Kmoles of SO_3. Find the conversion of SO_2. **(04 Marks)**

Module-4

7 a. Explain the general energy balance procedure. **(10 Marks)**

b. In the range of 200 K – 300 K NH_3 has a heat capacity given by
$C_p = a + bT + cT^2 + dT^3$ kJ/Kmol.K
where a = 20.1494; b = 845.765×10^{-3} ; c = -4067.45×10^{-6} ; d = 6606×10^{-9}
Determine the average C_p of NH_3 in the temperature range. **(10 Marks)**

OR

8 a. Write short notes on the following:
i) Heat of reaction ii) Hess's law of heat summation
iii) Heat of combustion iv) Heat of formation **(10 Marks)**

b. Calculate the heat of formation of Benzoic acid crystals (C_6H_5COOH) using Hess's law of heat summation from the following:
Data: $\Delta H_f CO_2 = -393.5$ kJ/mol
$\Delta H_f\ H_2O = -285.83$ kJ/mol
$\Delta H_c\ C_6H_5COOH = -3226.9$ kJ/mol **(10 Marks)**

Module-5

9 a. Enumerate the applications of modern biotechnological process. **(10 Marks)**

b. Explain the role of generalized process flow sheets in bioprocess industry with a suitable example. **(10 Marks)**

OR

10 a. Explain the different downstream process involved in the production of ethanol. **(10 Marks)**

b. What is the role of biotechnology engineer in bioprocess industry? **(10 Marks)**

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