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Fourth Semester B.E. Degree Examination, Dec.2018/Jan.2019 Bioprocess Principles and Calculations

Time: 3 hrs.

Max. Marks: 80

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

Module-1

- 1 a. How many grams of carbon is present in 264 gm of CO₂? (04 Marks)
- b. A mixture of methane and ethane has a density of 1 kg/m³ at 273 K and 101.325 kPa. Calculate the mol% and weight% of methane and ethane in the mixture. (08 Marks)
- c. Write a note on general material balance equation. How does it simplify to a steady state process. (04 Marks)

OR

- 2 a. Define Amagatz and Dalton's law and for an ideal gas mixture prove that mol% = volume% = pressure%. (08 Marks)
- b. Define the following :
(i) Normality (ii) Molarity (iii) Molality (iv) PPM. (08 Marks)

Module-2

- 3 a. A tank of weak Battery acid contains 12.43% H₂SO₄. If 200 kg of 77.7% H₂SO₄ is added to the tank and the final solution contains 18.63% H₂SO₄. How many kgs of battery acid have been made? (06 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 adheres. 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 :

Temp (°C)	Solubility $\left(\frac{\text{kg}}{\text{kg of water}}\right)$
100	1.8
25	0.72

(10 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). (06 Marks)

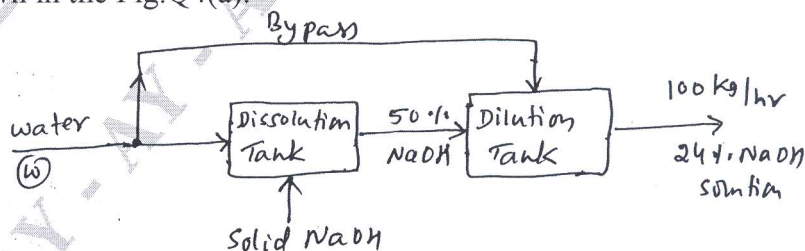


Fig.Q4(a)

To get 100 kg/hr of 24% NaOH solution, how much solid NaOH required and how much water to be bypassed per hour?

- b. List and explain the different types of fuels. (06 Marks)
- c. Write a note 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 charge is sustainable? (10 Marks)
- b. Explain the following :
 (i) Limiting reactant
 (ii) Conversion
 (iii) Selectivity
 (iv) Excess reactant (06 Marks)

OR

- 6 a. Phenol is produced by reaction of chlorobenzene with NaOH according to reaction given by

$$\text{C}_6\text{H}_5\text{Cl} + \text{NaOH} \longrightarrow \text{C}_6\text{H}_5\text{OH} + \text{NaCl}$$
 In a particular batch operation 1320 kg of chlorobenzene is mixed with 1200 kg of NaOH solids to product 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)

Module-4

- 7 a. Explain the general energy balance procedure. (08 Marks)
- b. In the range of 200 - 300 K ammonia has a heat capacity given by

$$C_p = a + bT + cT^2 + dT^3 \frac{\text{kJ}}{\text{kmol.K}}$$
 where $a = 20.1494$; $b = 845.765 \times 10^{-3}$; $c = -4067.45 \times 10^{-6}$; $d = 6606 \times 10^{-9}$
 Determine the average C_p of ammonia in the temperature range. (08 Marks)

OR

- 8 a. Write a short note on the following :
 (i) Net calorific value
 (ii) Gross calorific value
 (iii) Heat of combustion
 (iv) Heat of formation
 (v) Heat of reaction (10 Marks)
- b. Calculate the heat of formation of Benzoic acid crystals using Hess's law of heat summation from the following data:

$$\Delta H_f \text{ CO}_2 = -393.5 \text{ kJ/mol}$$

$$\Delta H_f \text{ H}_2\text{O} = -285.83 \text{ kJ/mol}$$

$$\Delta H_e \text{ C}_6\text{H}_6\text{COOH} = -3226.9 \text{ kJ/mol}$$
 (06 Marks)

Module-5

- 9 a. Enumerate the applications of modern Biotechnological process. (06 Marks)
b. Explain the role generalized process flow sheets in bioprocess industries, with a suitable example. (10 Marks)

OR

- 10 a. Write a short note on the following :
(i) Specific growth rate
(ii) Yield coefficients (Y_{X/O_2} , $Y_{X/S}$)
(iii) Degree of reduction
(iv) Respiratory Quotient (RQ)
(v) Elemental balance for bioprocess reaction. (10 Marks)
- b. Discuss how bioprocess engineers play a very important role in biotechnology industry. (06 Marks)

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