

CBCS Scheme

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15BT44

Fourth Semester B.E. Degree Examination, June/July 2018 Bioprocess Principles & Calculations

Time: 3 hrs.

Max. Marks: 80

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

Module-1

- 1 a. An aqueous solution of K_2CO_3 contains 50% salt and the specific gravity of the solution is 1.53. Determine the following:
- The mole percent of the salt in the solution.
 - The volume percent of water assuming density of water is 1000 kg/m^3 and there is no volume change on mixing.
 - The molality of the solution.
 - The molarity of the solution.
 - The normality of the solution
- (10 Marks)
- b. The percentage of methanol in the feed of 3500 kg/h is 30% (mole) for a distillation column. The distillate contains 97% of methanol and 3% of water. Determine the flow rate of distillate and residue.
- (06 Marks)

OR

- 2 a. Pure water and alcohol are mixed to get a 60% (wt) alcohol solution. The densities (kg/m^3) of water, alcohol and the solution may be taken to be 998, 798 and 895 respectively at 293 K . Calculate the following:
- The volume percent of ethanol in the solution at 293 K .
 - The molarity.
 - The molality.
- (07 Marks)
- b. A 150 L oxygen cylinder contains gas at 300 K and 10 bar . What is the mass of oxygen in the cylinder?
- (06 Marks)
- c. Do the material balance around dryer and evaporator.
- (03 Marks)

Module-2

- 3 a. Coal contains 85% carbon and 15% ash. The cinder formed in the combustion of coal contains 80% ash and 20% carbon. Determine the weight of cinder formed by the combustion of 100 kg of coal and the percent of fuel value that is lost.
- (06 Marks)
- b. Discuss various characteristics relevant to biofuels.
- (04 Marks)
- c. Explain the empirical procedure for analysis of fuel.
- (06 Marks)

OR

- 4 a. A drier is fed with wet solid to reduce the moisture content from 80% to 15%. The product leaving the drier is admitted to an oven which further brings down the moisture to 2%. If the drier can handle 1000 kg of wet solid per day, calculate
- The weight of products leaving the drier and the oven per day.
 - The percentage of the original water that is removed in the drier and the oven.
- (10 Marks)
- b. Discuss different types of fuels.
- (06 Marks)

Module-3

- 5 A fuel oil containing 70% carbon by wt and the rest combustible hydrogen and moisture is burned with excess air. The flue gas analysed 9% CO₂, 2% CO, 3% O₂ and 86% N₂. Determine the following:
- The percentage of excess air.
 - The ratio of carbon to combustible hydrogen in the fuel on a wt basis.
 - The ratio of carbon to total hydrogen in the fuel on a weight basis.
 - The percentage of combustible hydrogen and moisture in the fuel.
 - The mass of moisture present in the flue gas per kg of oil burned. (16 Marks)

OR

- 6 Propane is burned with excess air to ensure complete combustion. If 55 kg of CO₂ and 15 kg of CO are obtained when propane is completely burned with 500 kg air, determine the following:
- The mass of propane burnt (in kg)
 - Excess percentage of air.
 - Composition of flue gas. (16 Marks)

Module-4

- 7 a. Define std heat of reaction and std heat of formation with suitable examples. (06 Marks)
 b. The heat of combustion of methane, carbon and hydrogen are -890.4 kJ/mol, -393.51 KJ/mol and -285.84 KJ/mol respectively. Calculate the heat of formation of methane. (10 Marks)

OR

- 8 a. Calculate the std heat of formation of acetylene (C₂H₂) given that the std heat of combustion of acetylene is -1299.6 KJ the std heat of combustion of carbon is -393.51 KJ and the std heat of formation of liquid water is -285.84 KJ. (06 Marks)
 b. Methanol is synthesized according to the following reaction:

$$\text{CO(g)} + 2\text{H}_2\text{(g)} \rightarrow \text{CH}_3\text{OH(g)}$$
 The std heat of formation at 298 K are -110.6 KJ/mol for CO and -238.64 KJ/mol for methanol. The latent heat of vaporization of methanol at 298 K is 37.98 KJ/mol. The specific heats (J/molK) are given by,

$$C_p(\text{CH}_3\text{OH}) = 18.382 + 101.564 \times 10^{-3}T - 28.683 \times 10^{-6}T^2$$

$$C_p(\text{CO}) = 28.068 + 4.631 \times 10^{-3}T - 2.5773 \times 10^{-4}T^2$$

$$C_p(\text{H}_2) = 27.012 + 3.509 \times 10^{-3}T + 6.9006 \times 10^{-4}T^2$$
 Calculate the std heat of reaction at 1073 K. (10 Marks)

Module-5

- 9 a. With a neat flow chart, explain the production of ethanol. (10 Marks)
 b. Write a note on stoichiometry involved in microbial growth and product formation. (06 Marks)

OR

- 10 a. Give an account of development of bioprocess technology. (06 Marks)
 b. Discuss various unit operations of upstream and downstream operations of biotechnological process. (10 Marks)
