

Ref. No. : Ex/FTBE/BS/B/T/214/2024(S)

Name of the Examinations: B.E. FOOD TECHNOLOGY AND BIO-CHEMICAL
ENGINEERING SECOND YEAR FIRST SEMESTER SUPPLEMENTARY EXAM - 2024

Subject : CHEMICAL ENGINEERING
FUNDAMENTALS

Time : 3 hours

Full Marks : 100

Use separate answerscript for each part
Part A (50 Marks)

Answer Question no. 5 and any two from the rest.

1. (a) What is a fundamental unit and a derived unit? Give examples of one each.
(b) The flow rate of water through a pipe is $20 \text{ ft}^3/\text{min}$. Taking density of water as 1 g/cm^3 , calculate the mass flow rate in kg/s .
(c) The weight of an object is 315 N at a location where acceleration due to gravity is 9.82 m/s^2 . Determine the mass of the object in kilograms. 4+8+8
2. (i) A wet stock of ammonium sulphate containing 20% water is sent to a dryer. The material leaving the dryer contains 3% moisture. Determine how much water is removed per 100 kg of wet material charged. Also find the percentage of original water in the feed that is removed by drying. 10
(ii) An aqueous solution of ethanol containing 10% by weight ethanol is continuously distilled at a rate of 1100 kg/hr in a distillation column. 12% percent of the feed is recovered as distillate product (overhead) which contains 60% ethanol and 40% water. Calculate the composition of the bottom product. 10
3. A producer gas contains 9.2% CO_2 , 21.3% CO , 18% H_2 , 2.5% CH_4 and the rest N_2 . The gas is burnt with an excess supply of air. The flue gas analysed as 9.05% CO_2 , 1.34% CO , 9.98% O_2 and 79.63% N_2 . Determine the following:
(a) The mole ratio of air supplied to the fuel burnt.
(b) The percent excess air supplied.
(c) The percentage of N_2 in the flue gas that came from the producer gas. 20
4. Dry salt is to be produced at a rate of 25000 kg/hr by evaporating water from a feed containing 25% NaCl . The brine (28% NaCl) leaving the evaporator is recycled back to the evaporator. If the brine produced is 30% of the weight of dry salt, calculate the feed rate. 20
5. Answer any one of the following: 10
(i) Importance of Recycle process in the industry.
(ii) The viscosity of water is 1 cP . Express it in kg/m.s and lb/ft.hr

[Turn over

Ref. No.: Ex/FTBE/BS/B/T/214/2024(S)

B.E. FOOD TECHNOLOGY AND BIO-CHEMICAL ENGINEERING SECOND YEAR FIRST SEMESTER SUPPLEMENTARY EXAM – 2024

Department: Food Technology and Bio-Chemical Engineering (F.T.B.E)

Subject: Chemical Engineering Fundamentals (FTBE/BS/B/T/214)

Year: 2nd Semester: 1st

Full Marks: 50

Part II

Answer Q.1 (compulsory) and any two from the following:

- Q.1 (i) A gas containing CO and N₂ with a mole ratio of 3:1 is burnt completely with 30% excess air. If 280 MJ of heat is evolved per k.mol of CO burnt, what would be the temperature of the combustion products? Assume that the gas and air are at 27°C. Average heat capacities in kJ/k.mol °K are as follows: CO = 33.08, CO₂ = 50.66, O₂ = 33.08, N₂ = 31.4
- (ii) Estimate the outlet compositions (in mole percent). What is mole ratio of the combustible gas and the air at the inlet of the combustion chamber? **12+8 = 20**
- Q.2 (i) The heat of formation of H₂O (g) is -58 k.cal at 300°K. What will be the heat of formation at 327°C? The molar heat capacities in cal/mol °K are given as follows:
 $C_p(\text{H}_2) = 7 - 0.2 \times 10^{-3}T$, $C_p(\text{O}_2) = 6.0 + 4 \times 10^{-3}T$, $C_p(\text{H}_2\text{O}) = 7.25 + 0.2 \times 10^{-3}T$
- (ii) Given the heats of formation of NH₃ and HF gas are -46.1 kJ and -271.1 kJ, respectively. Find out the heat of gaseous reaction, 2NH₃ + 3F₂ = N₂ + 6HF **8 + 7 = 15**
- Q.3 (a) Calculate the heat produced for the formation of C₆H₆ from the polymerization of C₂H₂ at constant pressure from the following data: At constant volume, 27°C
- (i) $2 \text{C}_6\text{H}_6 + 15\text{O}_2 = 12 \text{CO}_2 + 6 \text{H}_2\text{O}$, $\Delta H = -1600 \text{ Kcal}$
- (ii) $2 \text{C}_2\text{H}_2 + 5\text{O}_2 = 4 \text{CO}_2 + 2 \text{H}_2\text{O}$, $\Delta H = -620 \text{ Kcal}$
- (b) Calculate the heat produced in the reaction, 3Mg + Fe₂O₃ = 3MgO + 2Fe, Given: $\Delta H_f, \text{MgO} = -145.7 \text{ K.cal/mol}$ and $\Delta H_f, \text{Fe}_2\text{O}_3 = -193.5 \text{ K.cal/mol}$ **10+5 = 15**
- Q.4 (i) 480 kg of CH₄ is burnt in presence of theoretical amount of air. Estimate the fuel- air ratio for such combustion process. Also estimate the product distribution (mole%) at the exit. (ii) Estimate the mean heat capacity of CH₄ if it is heated from 27°C to 500°K, assuming the heat capacity of CH₄ is as follows: $C_p(\text{CH}_4) = 14.15 + 0.0755T \text{ kJ/k-mol-}^\circ\text{K}$ **10+5 = 15**
- Q.5 Write short notes on (with examples) the following: **3×5 = 15**
- (i) Heat of Formation (ii) Heat capacity (iii) Laws of Thermochemistry