Reg. No. : | | | | | | | | | | |

Question Paper Code: 93D02

B.E./B.Tech. DEGREE EXAMINATION, DEC 2021

Third Semester

Bio technology

19UBT302 - Stoichiometry

(Regulation 2019)

Duration: Three hours | Maximum: 100 Marks

Answer ALL Questions

PART A - (10 x 2 = 20 Marks)

1.	Convert 499 g of $CuSO_4.5H_2O$ into moles.	CO2-Ana
2.	How many pounds of NaOH are in 15 g mole of NaOH?	CO2-Ana
3.	Define Henry's law	CO1- U
4.	Define the following terms. A) Dry bulb temperature. B) Wet bulb temperature.	CO1- U
5.	What is a unit operation? Mention any two unit operations.	CO1- U
6.	What is a recycle operation? Why it is done. Give one example	CO3-Ana
7.	What is Percentage Yield? How do you calculate it?	CO1- U
8.	Explain about excess reactant	CO1- U
9.	What is standard heat of combustion?	CO1- U
10.	Define Hess's Law.	CO1- U

PART – B (5 x 16= 80 Marks)

11.	(a)	A gaseous mixture has following compound by volume (methane 10%, ethane 30%, and hydrogen60%) and flows at the rate of 1500 l/s at 303k and 2000 mm hg guage pressure. Calculate a. Mole fraction of each component b. Concentration of each component in mol/l c. Partial pressure of each component d. Mass flow rate in Kg/hr	CO5- Eva	(16)

Or

(b) The resistance force 'R' of a particularly submerged body in water can be expressed in the form CO5- Eva (16)

$$R=\rho l^2V^2[\mu/lV\rho,lg/V^2]$$

Where

R = Resistance force ($Kg.m/s^2$)

l = length of the body (m)

V=Velocity (m/s)

ρ- Density (kg/m^3)

μ =viscosity of water (kg/ms)

G=acceleration due to gravity (m/s^2)

Using Buckingham's pi theorem, show that resistance force 'R' of a particularly submerged body inwater can be expressed in the form

12. (a) An air–water vapour sample at 101.3 kPa has a dry-bulb temperature of 328 K and is 10% saturated with water vapour. Using the psychometric chart determine the following: CO5- Eva (16)

i. The absolute humidity, kg water vapour per kg dry air
ii. The partial pressure of water vapour
iii. The absolute saturation humidity at 328 K
iv. The vapour pressure of water at 328 K
v. The percent relative saturation

The dew point of the system

Or

(b) The feed containing 50% Benzene and 50% Toluene is fed to a distillation column at a rate of 5000 kg/h.The top product contains 85% Benzene and bottom product contains 92% Toluene. All percentage is by weight. Calculate: CO5- Eva (16)

(i) The mass flow rate of top and bottom products

(ii) The percentage recovery of benzene.

13. (a) In a contact process for H_2SO_4, a gas mixture of 8% (by volume) SO_3 and rest inert is sent to a absorption tower at the rate of 30 kgmol/h where it is contacted with 96% H_2SO_4 counter currently fed from top of the tower. 98.5% SO_3 is absorbed to produce 98% (by weight) H_2SO_4. Part of this solution is withdrawn as CO5- Eva (16)

final product and the rest is mixed with 95.6% H_2SO_4 coming from a air drying tower to produce 96% H_2SO_4, which is fed from top. Calculate:

A. Mass of 95.6% H_2SO_4 make up acid required per hour.
B. Mass of 96% H_2SO_4 fed from top of tower per hour.
C. Mass of 98% H_2SO_4 solution produced per hour.

Recycle ratio. Assume physical absorption.

Or

(b) 10,000 kg/h of solution containing 20% methanol is continuously fed to a distillation column. Distillate is found to contain 98% methanol and waste solution from the column carries 1% methanol. All percentage are by weight. Calculate: (A) The mass flow rates of distillate and bottom product (B) The percentage loss of methyl alcohol. CO5- Eva (16)

14. (a) (i) Calcium oxide is formed by decomposing limestone pure $CaCO_3$. In kiln, the reaction goes to 70% completion. (A) What is the composition of the solid product withdrawn from the kiln? (B) What is the yield in kg of CO_2 produced per kg of limestone charged? CO5- Eva (8)

(Reaction: $CaCO_3 \rightarrow CaO + CO_2$)

(ii) In the combustion of Heptane, CO_2 is produced. Assume that you want to produce 600 kg of dry ice per hour and 50% of that CO_2 can be converted into dry ice. How many kg of Heptane must by burned per hour?(Reaction: $C_7H_{16} + 11O_2 \rightarrow 7CO_2 + 8H_2O$). CO5- Eva (8)

Or

(b) (i) In production of SO_3, 50 kgmol of SO_2 and 100 kgmol of O_2 are fed to the reactor. The product stream is found to contain 40 kgmol of SO_3. Determine the percentage conversion of SO_2. (Reaction: $SO_2 + O_2 = SO_3$) CO5- Eva (8)

(ii) Coke contains 85% carbon and 15% non-combustible material by weight. Calculate:(A) the amount of oxygen theoretically required to burn 120 kg of coke completely.(B) The composition of gases in the product stream if 60% excess air is supplied. CO5- Eva (8)

15. (a) (i) Derive the equation for the heat capacity at constant pressure and at constant volume. CO4-Eva (8)

(ii) How will you simplify the above derivation using mean molal heat capacity? CO4-Eva (8)

Or

(b) (i) Calculate the heat needed to raise the temperature of 2 kgmol of NH_3 for 350 K to 450 K using mean molal heat capacity. CO4-Eva (8)

Data: C^{o}_{pm1} for NH_3 between 298 K to 350

K = 36.86 kJ/kgmol KC^{o}_{pm2} for NH_3 between 298

K to 450 K = 38.71 kJ/kgmol K

(ii) Chlorinated diphenyl is heated from 303 K to 503 K in an indirectly fired heater at a rate of 3500 kg/h. The heat capacity of the fluid in this temperature range is given by the equation CO4-Eva (8)

case 1: $C_P = 0.751 + 1.465 \times 10 - 3T$, kJ/kg K

case 2: $C_P = 1.435 + 2.19 \times 10 - 3T$, kJ/(kg K)

Calculate the heat to be supplied to the fluid in the heater for above two cases