Department of Chemical Engineering

Mid Semester (Odd) Examination (Session 2022-23)

Programme Name: B.Tech.
Branch: Chemical Engineering
Duration: 90 Minutes

Semester: I
Course Name: Chemical Process Principles
Student Reg. No.:
Max. Marks: 20

Instructions:
1. Solve the questions as per the given sequence
2. Attempt all the questions

Question 1:
How many type of unit operations are used in Chemical industries? Describe the mass transfer operations in detail.

5 Marks

Question 2:
The flow rate of water through a pipe is reported as 20 cubic feet per minute. Taking density of water as 1 g/cm^3, calculate the mass flow rate in kg/s.

2 Marks

Question 3:
How many molecules are present in 791 g K_2CO_3?

2 Marks

Question 4:
Natural gas is piped from the well at 300 K and 400 kPa. The gas is found to contain 93.0%, 4.5% ethane and the rest nitrogen. Calculate the following: (a) The partial pressure of nitrogen (b) The pure-component volume of ethane in 10 m^3 of the gas (c) The density at standard condition in Kg/m^3 (d) The density of the gas as piped in kg/m^3 (e) The average molecular weight of the gas (f) The composition in weight percent

6 Marks

Question 5:
A liquid mixture containing 65 mol % benzene and 35 mol % toluene is subjected to flash vaporization at 363 K and 101.3 kPa. The vapour pressure of benzene at this temperature is 136.09 kPa and the vapour pressure of toluene is 54.21 kPa. Flash vaporization is essentially an equilibrium stage operation. Calculate the mole percent of the feed that is vaporized.

5 Marks

Department of Chemical Engineering   20222068

End Semester (Odd) Examination (Session 2022-23)

Programme Name: B.Tech.   Semester: I
Course Code: CHN11101   Course Name: Chemical Process Principles
Branch: Chemical Engineering   Student Reg. No.:
Duration: 2:30 Hours   Max. Marks: 50

Instructions:
1. Solve the questions as per the given sequence
2. Attempt all the questions

Question 1(a):
How chemical engineering is different from chemistry? Provide the detail of major chemical process industries with product and it's uses.

4 Marks

Question 1(b):
How many type of unit operations are used in Chemical industries? Describe the mass transfer operations in detail.

4 Marks

Question 2(a):
Convert the heat transfer coefficient of value 200 Btu/h.ft^2.°F into W/m^2°C.

3 Marks

Question 2(b):
A gaseous mixture analyzing CH_4:10%, C_2H_6:30% and rest H_2 at 15°C and 1.5 atm is flowing through an equipment at the rate of 3 m^3/min. Find (a) the average molecular weight of the gas mixture, (b) weight % and (c) the mass flow rate.

5 Marks

Question 3(a):
It is desired to compress 40 lb of CO_2 to a volume of 30 ft^3 at 30°C. Find the pressure of the gas stored?

4 Marks

1

Question 3(b):

Vapour pressure of pure benzene and toluene are 950 mm Hg and 350 mm Hg respectively at 86 °C. Calculate the liquid phase and vapour phase composition at that temperature. Total pressure=760 mm Hg

4 Marks

Question 4(a):

Write the definitions with formula of the following: (a) Absolute humidity (b) Relative humidity (c) Dew point (d) Humid Heat.

4 Marks

Question 4(b):

A crystallizer is charged with 6500 kg of an aqueous solution containing 25% of anhydrous sodium sulphate. The solution is cooled and 10% of the initial water is lost by evaporation. $Na_2SO_4.10H_2O$ crystallizes out. If the mother liquor (after crystallization) is found to contain 18.3% Na_2SO_4, calculate the weight of mother liquor.

4 Marks

Question 5(a):

A mixture of 5% ethylene and 95% air is passed through a suitable catalyst in a reactor. Some of the ethylene does not react, some form oxide, some turn to CO_2 and water. The entire gas mixture enters an absorption tower where water is sprayed. The oxide is converted to glycol. The gas leaving the absorber analyzes C_2H_4:1.085%, CO_2:4.345%, O_2:13.055% and N_2:81.515% on dry basis. The partial pressure (pp) of H_2O in this gas is 15.4 mm Hg while total pressure is 745 mm Hg. If one mole of water is sprayed per 100 mole of gas mixture, calculate the composition of ethylene glycol-water product formed.

Reactions:
1. $2C_2H_4 + O_2 \rightarrow 2C_2H_4O$
2. $C_2H_4 + 3O_2 \rightarrow 2CO_2 + 2H_2O$
3. $C_2H_4O + H_2O \rightarrow (CH_2OH)_2$

5 Marks

Question 5(b):

A contact sulphuric acid plant produces 98% acid. A gas containing 8% SO_3 (rest inert) enters a SO_3 absorption tower at the rate of 28 kmoles/h 98.5% of SO_3 is absorbed in this tower by 97.3% acid introduced at the top and 95.9% acid is used as the make up acid. Compute tonne/day of (a) make up acid required (b) acid fed at the top of the tower and (c) acid produced.

5 Marks

Question 6(a):

Calculate the amount of heat given off when 1 m^3 of air at standard conditions cools from 500 °C to −100 °C at constant pressure.

C_p air= $6.386 + 1.762 * 10^{-3} T - 0.2656 * 10^{-6} T^2$, where C_p is in kcal/kmole K and T in K.

3 Marks

Question 6(b):

From the following data compute the enthalpy change of formation for NH_3 at 480 °C.

ΔH_f at 25 °C for NH_3 = -10.96 kcal/kmol, for N_2 = 0 and for H_2= 0.

C_p N_2 = $6.76 + (6.06 * 10^{-4}T) + (13 * 10^{-8}T^2)$
C_p H_2 = $6.85 + (2.8 * 10^{-5}T) + (22 * 10^{-8}T^2)$
C_p NH_3 = $6.703 + (0.0063T)$ where T is in K,
$N_2 +3H_2 \rightarrow 2NH_3$

5 Marks

2