17315

15116

3 Hours / 100 Marks Seat No. | | | | | | | | |

Instructions : *(1)* ***All*** *questions are* ***compulsory****.*
(2) Answer ***each*** *next main question on a* ***new*** *page.*
(3) Illustrate your answers with neat sketches ***wherever*** *necessary.*
(4) Figures to the ***right*** *indicate* ***full*** *marks.*
(5) Assume suitable data, if ***necessary****.*
(6) Use of Non-programmable Electronic Pocket Calculator is ***permissible****.*
(7) Mobile Phone, Pager and any other Electronic Communication devices are ***not permissible*** *in Examination Hall.*

Marks

1. A) Answer **any four.** **8**

a) Give the mathematical expression of ideal gas law and explain the terms involved.

b) Write down the principle involved in solving material balance problems without chemical reaction.

c) State Amagat's law and give its mathematical expression.

d) Explain Raoult's law.

e) Define adiabatic reaction and adiabatic reaction temperature.

f) Define the following.

i) conversion

ii) yield

B) Answer **any two**. **12**

a) Calculate the density of air at NTP. Air contains 79% N_2 and 21% O_2 by volume (Atomic weight of N = 14, O = 16)

b) Find the partial pressure of CO_2 in the gas phase if mol fraction of CO_2 is 4×10^{-6} and Henry's law constant for CO_2 in water is 7×10^6 KPa / mole fraction.

c) A sample of gas having volume of 0.8 m^3 is compressed in such a manner so that pressure is increased by 50%. The operation is done for a fixed mass of gas at constant temperature. Calculate the final volume of gas.

P.T.O.

Marks

2. Answer **any four**. **16**

a) Explain the steps involved in solving material balance problems without chemical reactions.

b) The NH_3-air mixture containing 0.2 kg NH_3 per kg air enters into absorption system where ammonia is absorbed in water. The gas leaving the system is found to contain 0.004 kg NH_3 per kg of air. Find % recovery of ammonia.

c) Define
   i) limiting component.
   ii) excess component

d) 100 kg moles of ethanol are charged to dehydrogenation reactor to produce acetaldehyde. The product stream is found to contain 45 kg moles acetaldehyde. Find % conversion of ethanol.

e) In production of SO_3, 100 kg moles of SO_2 and 75 kg moles of O_2 are fed to reactor. Calculate % excess O_2 fed.

f) At what rate in kcal/hr heat must be transferred to liquid C_2H_5OH at its boiling point to generate 100 kg/hr of C_2H_5OH vapour ? λ for C_2H_5OH = 202 kcal/kg.

3. Answer **any two**. **16**

a) Ethylene oxide is produced by the oxidation of ethylene. 100 kg moles ethylene are fed to the reactor and product is found to contain 80 kg moles C_2H_4O and 10 kg moles CO_2. Calculate
   i) % conversion of ethylene
   ii) % yield of ethylene oxide.

b) It is desired to have a mixed acid containing 42% HNO_3, 45% H_2SO_4 and rest water by weight. Sulfuric acid of 98% is readily available. Calculate a) strength of HNO_3 required to obtain desired acid. b) Weight ratio of con.H_2SO_4 to con. HNO_3.

c) 20,000 kg/hr of solution containing 25% methanol is fed to a distillation column. Distillate is found to contain 98% methanol and waste solution from column carries 1% methanol (by weight). Calculate
   i) mass flow rate of distillate and bottom products
   ii) % loss of methanol

4. Answer **any two**. **16**

a) Calculate the heat of formation of liquid 1-3 butadiene (C_4H_6) at 298.15 K using following data.
   Standard heat of formation of CO_2 = –393.51 kJ/mol
   Standard heat of formation of H_2O = –285.83 kJ/mol
   Heat of combustion of C_4H_6 = –2520.11 kJ/mol

b) Tray dryer is fed with 1000 kg of wet solid containing 15% water. The dried product contains 99.5% solids and rest water. Find the % of original water that is removed in the dryer.

c) SO_2 is oxidised to SO_3. If conversion is 70% and air is used 80% in excess over theoretical requirement, calculate composition of gas leaving reactor on mole basis.

Marks

5. Answer **any two**. **16**

a) A gas stream containing 65 mol % ethane and 35 mol % butane is fed to a combustion chamber where it is oxidised to CO_2 and H_2O. Air is supplied 20% excess of that theoretically required. Calculate the amount of gas leaving the chamber per 100 kg gas fed assuming complete combustion.

b) An evaporator system concentrating a weak liquor from 5% to 50% solids handles 100 kg-solids/hr. If the same system is to concentrate a weak liquor from 4% to 35%, find the capacity of the system in terms of solids that can be handled per hour assuming water evaporation capacity to be same in both the cases.

c) Calculate the change in enthalpy between reactants and products if both are at 25°C and if 5 gmol of ethylene oxide is produced.

$$C_2H_4\,(g) + \frac{1}{2}\,O_2\,(g) \rightarrow C_2H_4O(g)$$

Compound	$\Delta H°_f$ in kcal/gmol
C_2H_4	12.50
C_2H_4O	– 12.58

6. Answer **any four**. **16**

a) Define stoichiometric equation and stoichiometric coefficient. Explain with example.

b) The groundnut seeds containing 45% oil and 45% solids are fed to expeller, the cake coming out of expeller is found to contain 80% solids and 5% oil. Find % recovery of oil.

c) The dilate acid containing 25% H_2SO_4 is concentrated by commercial grade H_2SO_4 containing 98% H_2SO_4 to obtain desired acid containing 65% H_2SO_4. Find the quantities of the acids required to make 1000 kg desired acid.

d) A combustion reactor is fed with 50 kgmoles of butane and 35 mol % excess O_2. Calculate kgmoles of O_2 fed.

e) The feed containing 60 mol %A, 30 mol % B and 10 mol % inerts enters a reactor. The product stream leaving the reactor is found to contain 2 mol %A. The reaction taking place is $2A + B \rightarrow C$. Find the % of original A getting converted to C.

f) Define :

i) sensible heat

ii) latent heat.