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(Revision 2015)

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DIPLOMA EXAMINATION IN ENGINEERING/TECHNOLOGY/MANAGEMENT/
COMMERCIAL PRACTICE- APRIL - 2018.

CHEMICAL PROCESS PRINCIPLE

(Maximum Marks : 100) Time : 3 Hrs

PART–A
(Maximum marks: 10)

Marks

I. Answer all questions in one or two sentences. Each question carries 2 marks.

1. Define partial pressure.
2. State the specific gravity of the gas mixture.
3. State the material balance equations of solid and moisture of a drying operation.
4. Define stoichiometric ratio.
5. Define isolated system. (5X2=10)

PART - B
(Maximum Marks : 30)

II Answer any five of the following questions . Each question carries 6 marks.

1. State the following
   (i) Dalton's law (ii) Average molecular weight of a gas mixture.
   (iii) Densty of gas mixture.
2. A gas mixture contains 0.274Kmol of HCl.0.337Kmol of N_2 and 0.089Kmol of O_2. Calculate (i)Average molecular weight of gas and (ii) Volume occupied by this mixture at 405.3Kpa and 303K.
3. Explain about crystallization with material balance equations and block diagram.
4. The NH_3 air mixture containing 0.2kg NH_3/Kg of air enters into absorption system where ammonia is absorbed in water. The gas leaving the system is found to contain 0.004kg NH_3/kg of air.
   Find percentage recovery of ammonia.
5. Compute the % excess, %conversion and % yield of a reaction A+B→C B is the excess reagent. The Carbon monoxide is reacted with hydrogen to produce methanol.

6. Calculate from the reaction (i) the stoichiometric ratio of H_2 to CO.

(ii) kmol of CH_3OH produced per kmol of CO reacted.

(iii) the weight ratio of CO to H_2 if both are fed to reactor in stoichiometric Proportion $CO+2H2 \rightarrow CH_3OH$.

7. State the following

(i) State function.

(ii) Internal energy

(iii) Heat capacity.

[5x6 =30]

PART - C

(Maximum marks : 60)

(Answer one full question from each unit. Each full question carries 15 marks)

UNIT I

III (a) Derive the relation mole % = pressure%= volume% (10)

(b) A sample of a gas having volume of $0.5m^3$ is compressed in such a manner so that the pressure is increased by 60%. The operation is done for a fixed mass of a gas at constant temperature. Calculate the final volume of the gas. (5)

OR

IV (a) A gas mixture has the following composition by volume. Ethylene:30.6%, Benzene:24.5%, Oxygen:1.3%, Methane:15.5%, Ethane:25%, Nitrogen:3.1%. Find (i) the average molar mass of the gas mixture
(ii) the composition by mass. (8)

(b) A mixture of CH_4 and C_2H_6 has density 1.0kg/m at 273K (0°c) and 101.325kPa pressure. Calculate the mol% of the gas mixture. (7)

UNIT- II

V (a) The feed containing 50% Benzene and 50% Toluene is fed to a Distillation column at the rate of 5000kg/h. A top product contains 95% Benzene and the bottom product contains 92% toluene by weight. Calculate (i) the mass flow rate of the top and bottom product.
(ii) % recovery of benzene. (8)

(b) How many kilograms of potassium nitrate will crystallize from 100Kg O f a solution saturated at 333K (60°c) if it cooled to 273K? The solubility of potassium nitrate at 333K (60°c) is 110 and at 273K (0°c) Is 13kg/100kg of water. Assume no evaporation during crystallization Process. (7)

Or

VI a) 2000kg of wet solids containing 70% solids by weight are fed to a tray dryer where it is dried by hot air .The product finally obtained is found to contain 1% moisture by weight. Calculate(a) kg of water removed from wet solids (b) Kg of product obtained 7

b) An aqueous solution of pyridine containing 27% (by weight) pyridine and 73%(by weight) water is to be extracted with chlorobenzene. The feed and solvent are mixed well in batch extractor and the mixture is allowed to stand for phase separation. The extract phase contains 11% pyridine and 88.1% chlorobenzene and 0.9% water by weight. The raffinate phase contains 5% pyridine and 95% water by weight.Calculate (a)the quantities of two phases(b) the weight ratio of solvent to feed 8

UNIT-III

VII a) In manufacture of Acetic acid by oxidation of acetaldehyde,100 kmol of acetaldehyde is fed to reactor per hour .The product leaving the reactor contains 14.8% acetaldehyde,59.26% acetic acid and rest oxygen (mol basis).Find percentage conversion of acetaldehyde 8

b) In production of SO_3 and 100kmol SO_2 and 100kmolO_2 are fed to the reactor. If the % conversion of SO_2 is 80. Calculate the composition of product stream on mol basis 7

Or

VIII a) Chlorine can be produced by reacting Suphuric acid with a mixture of NaCl and MnO2 according to the following reaction 7

$2NaCl + MnO_2 + 3H_2SO_4 \rightarrow 2NaHSO_4 + 2H_2O + Cl_2$

Calculate the volume of Chlorine at NTP that can be produced from 1kg of NaCl

b) A combustion chamber is fed with butane and excess air.Combustion of butane is complete. The composition of combustion gases on volume basis is given below 8

CO_2= 9.39% ,H_2O = 11.73% , O_2= 4.70 %, and N_2= 74.18%

Find percentage excess air used and mole ratio of air to butane used

UNIT-IV

IX a) Identifies the relation between pressure, volume and work 8

b) Calculate the heat of formation of phenol crystals at298.15K(25^0c) from the elements using following data

standard heat of formation of $CO_2(g)$ = -393.5kJ/mol

standard heat of formation of $H_2O(i)$ = -285.83kJ/mol 7

heat of combustion of Phenol Crystals at 298.18K(25^0c) = -3053.51kJ/mol

X a) Define the following

i) Heat of reaction 2

ii) Heat of combustion 2

iii) Closed system 2

iv) Hess's law 2

b) Calculate the standard heat of formation of Chloroform gas from its elements using Hess's law. Given the heat of combustion of benzene, carbon and hydrogen are-780kcal, -94.0kcal and -68.0kcal at 300K (27^0c) 7

Given data:

1) $C(s) + O_2(g) \rightarrow CO_2(g)$ $\Delta H1 = -393.51 kJ/mol$

2) $H_2(g) + \frac{1}{2}O_2(g) \rightarrow H_2O(l)$ $\Delta H2 = -285.83$ kJ/mol

$\frac{1}{2}H_2(g) + \frac{1}{2}Cl_2(g) \rightarrow HCl(aq)$ $\Delta H3 = -167.57$ kJ/mol

$CHCl_3(g) + \frac{1}{2}O_2(g) + H_2O(l) \rightarrow CO_2(g) + 3HCl(aq)$

$\Delta H_c^0 = -509.95$ kJ/mol