22315

21819

3 Hours / 70 Marks Seat No. | | | | | | | | |

Instructions : (1) All Questions are *compulsory.*

(2) Illustrate your answers with neat sketches wherever necessary.

(3) Figures to the right indicate full marks.

(4) Assume suitable data, if necessary.

Marks

1. Attempt any FIVE of the following : **10**

(a) Define sensible heat and latent heat.

(b) State Dalton's law and Amagat's law.

(c) Define heat capacity and give its SI unit.

(d) If evaporator operates under vacuum at 475 torr. Find the absolute pressure.

(e) Write the stoichiometric coefficient's for the given reaction :

$4HCl + O_2 \longrightarrow 2Cl_2 + 2H_2O$

(f) Define Net Calorific Value (NCV) and Gross Calorific Value (GCV).

(g) Draw a block diagram indicating material balance for distillation process.

2. Attempt any THREE of the following : **12**

(a) Convert a volumetric flow rate of 1000 m^3/h to l/s.

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

(c) A feed containing A, B and inerts enters a reactor. The reaction taking place is

$2\ A + B \rightarrow C$

The product stream leaving the reactor is having the following composition by mole :

A = 23.08%, B = 11.54%, C = 46.15% and inerts = 19.23%. Find the analysis of feed on mole basis.

(d) State and explain the Hess's law of constant heat summation.

3. Attempt any THREE of the following : **12**

(a) A sample of coal is found to contain 63% carbon and 24% ash on a weight basis. The analysis of refuse after combustion shows 7% carbon and rest ash. Calculate the % of the original carbon unburnt in the refuse.

(b) A dryer handle 1000 kg/hr of wet solids containing 50% solid to be dried to 20% moisture. Calculate percentage of original moisture removed.

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

(d) Calculate the heat needed to raise the temperature of 1 kmol of ammonia from 311 K to 422 K using the following mean molal heat capacity data :

C°_{pm} of NH_3 between 311 & 298 K = 35.86 kJ/(mol.K)

C°_{pm} of NH_3 between 422 & 298 K = 37.70 kJ/(mol.K)

4. Attempt any THREE of the following : **12**

(a) A mixture of CH_4 & C_2H_6 has the average molecular weight of 22.4. Find mole % CH_4 and C_2H_6 in the mixture.

(b) It is desired to have a mixed acid containing 40% HNO_3, 43% H_2SO_4 and 17% H_2O by weight. Sulphuric acid of 98% by weight is readily available. Calculate

(i) the strength of nitric acid and

(ii) the weight ratio of sulphuric acid to nitric acid.

(c) A combustion reactor is fed with 50 kmol/h of butane and 2100 kmol/h of air. Calculate the % excess air used.

(d) A sample of dry flue gas has the following composition by volume :
CO_2 = 13.4%, N_2 = 80.5%, O_2 = 6.1%

Find the % excess air supplied assuming that the fuel contained no nitrogen, the nitrogen and oxygen in flue gas must have come from air.

(e) A force equal to 19.65 kgf is applied on a piston with a diameter of 5 cm. Calculate the pressure exerted on the piston in kPa.

5. Attempt any TWO of the following : **12**

(a) In the manufacture of nitric acid initially ammonia and air are mixed at 810.325 kPa and 923 K the composition of the mixture (on vol. basis) is as follows : N_2 = 70.5%, O_2 = 18.8%, H_2O = 1.2%, NH_3 = 9.5%

Calculate the density of the gas mixture using ideal gas law.

(b) The average molecular weight of a flue gas sample is calculated by two different engineers. One engineer uses the correct molecular weight of 28 for N_2 and determines the average molecular weight to be 30.08, the other engineer uses an incorrect value of 14, and calculates the average molecular weight to be 18.74. Calculate

(i) the volume % of N_2 in the flue gases.

(ii) if the remaining components of the flue gases are CO_2 and O_2.

Find the volume % of each of them.

P.T.O.

(c) A gas mixture containing 15 mole % A and 85 mole % inerts is fed to an absorption tower where it is contacted with liquid solvent 'B' which absorbs 'A'. The mole ratio of solvent to gas entering tower is 2 : 1. The gas leaving the absorber contains 2.5% A, 1.5% B and rest inerts (on mole basis). Find

(i) the % recovery of solute 'A' and

(ii) the fraction of solvent (B) fed to the column lost in gas leaving the tower.

6. Attempt any TWO of the following : **12**

(a) In a oxidation process during production of chlorine gas by oxidation of hydrochloric acid gas. Air is used 30% in excess of that theoretically required, based on 4 kmol HC*l*, if oxidation is 80% complete. Find the composition of product stream on mole basis.

(b) A feed containing 60 mole % A, 30 mole % B and 10 mole % inerts a reactor. The product stream leaving the reactor is found to contain 2 mole % A. Reaction taking place is $2A + B \rightarrow C$.

Find the percentage of original 'A' getting converted to C.

(c) Calculate the heat of formation of phenol crystals at 298.15 °k from its elements using the following data :

Standard heat of formation of CO_2 = – 393.51 kJ/mole.

Standard heat of formation of H_2O = – 285.83 kJ/mole.

Heat of combustion of phenol at 298.15 °k = –3053.25 kJ/mole.