313336

24225

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

Instructions – (1) All Questions are *Compulsory.*

(2) Answer each next main Question on a new page.

(3) Figures to the right indicate full marks.

(4) Assume suitable data, if necessary.

(5) Use of Non-programmable Electronic Pocket Calculator is permissible.

(6) Mobile Phone, Pager and any other Electronic Communication devices are not permissible in Examination Hall.

Marks

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

a) State Dalton's Law and Write its mathematical statement.

b) Give mathematical expression of Vander Waal's equation.

c) State law of conservation of mass.

d) Define % conversion and % yield.

e) Define sensible heat and latent heat.

f) Define calorific value.

g) Compare complete combustion and incomplete combustion (any two points)

P.T.O.

Marks

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

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

b) Describe recycle and bypass operation with neat diagram.

c) In the production of SO_3, 100 Kmol of SO_2 and 200 Kmol of O_2 are fed to a reactor. The product stream is found to contain 80 Kmol SO_3. Find limiting and excess reactant with justification.

d) 100 kg/h of saturated C_2H_5OH vapour is generated from liquid stream of ethanol (C_2H_5OH) at its boiling point find out KJ/S of heat transferred to liquid stream of ethanol (C_2H_5OH).

Data : Latent heat of vaporization of ethanol = 842.3 $\frac{kJ}{kg}$

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

a) Convert a volumetric flowrate of 1000 $\frac{m^3}{n}$ to $\frac{l}{s}$.

b) Define steady state and unsteady state operation.

c) Feed containing 60% A, 30% B and 10% inerts entering a reactor. The product stream leaving the reactor is found to contain 2 mole % A.

Reaction is $2A + B \rightarrow C$. Find % conversion of A.

d) Calculate the heat that must be added to 3 Kmol air to heat it from 298 K to 473 K using the mean molal heat capacity data for air given below

C^{o}_{pm} (between 473 K and 298 K) = $29.3955 \frac{KJ}{Kmol.K}$

Marks

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

a) 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.

b) A feed to a continuous fractionating column analysis by weight 28% benzene and 72% toluene. The analysis of the distillate shows 52 weight % benzene and 5 weight % benzene was found in the bottom product. Calculate the amount of distillate and bottom product per 1000 kg of feed per hour. Also calculate the % recovery of benzene.

c) The carbon monoxide CO is reacted with hydrogen H_2 to produce methanol.

i) Write chemical reaction. Calculate from the reaction

ii) the stoichiometric ratio of H_2 to CO.

iii) kmol of CH_3OH produced per kmol CO reacted.

iv) the weight ratio of CO to H_2 if both are fed to reactor in stoichiometric proportion.

d) Calculate the standard heat of formation of n-propanol liquid using the following data.

Standard heat of formation of $CO_{2(g)} = -393.51 \frac{KJ}{mol}$

Standard heat of formation of $H_2O_{(1)} = -285.83 \frac{KJ}{mol}$

Standard heat of combustion of n-propanol liquid $= -2028.19 \frac{KJ}{mol}$

e) Explain Hess's law of constant heat summation with example.

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

a) A gas contained in a closed vessel at a pressure of 121.59 kPag and 299 K is heated to a temperature of 1000°C. Find the pressure to which a closed vessel should be designed.

b) Compare evaporation and drying operation (any two points) Draw block diagram and write overall material balance equation for evaporation operation.

Marks

c) 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 HCl, if oxidation is 80% complete find the composition of product stream on mole basis.

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

a) A waste acid from a nitrating process contains 23% HNO_3, 57% H_2SO_4 and 20% H_2O by wt. This acid is to be concentated to contain 27% HNO_3, 60% H_2SO_4 by the addition of concentrated H_2SO_4 containing 93% H_2SO_4 and concentrated HNO_3 containing 90% HNO_3. Calculated the amounts in Kg of waste and concentrated acids that must be combined to obtain 1000 kg of desired mixture.

b) The ammonia is produced by the following reaction.
$N_2 + 3H_2 \rightarrow 2NH_3$ Calculate –

i) The molal flowrate of hydrogen corresponding to nitrogen feed rate of 25 kmol/h if they are fed in the stoichiometric proportion.

ii) The kg of ammonia produced per hour if percent conversion is 25% and nitrogen feed rate is 25 kmol/h.

c) A coke containing 90% carbon and 10% noncombustible ash (by wt)

i) Calculate moles of oxygen theoretically required to burn 100 kg of coke completely.

ii) If 50% (mole) excess air is supplied calculate the analysis of gases at the end of combustion.