

22315

23124

3 Hours / 70 Marks

Seat No.

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- Instructions :**
- (1) All Questions are *compulsory*.
 - (2) Figures to the right indicate full marks.
 - (3) Assume suitable data, if necessary.

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

- (a) Give the SI unit of force & energy.
- (b) What are products of complete and incomplete combustion ?
- (c) Draw the block diagram of distillation unit showing all input and output.
- (d) Define : (i) Limiting component (ii) Excess component
- (e) Define : (i) Partial pressure (ii) Pure component volume
- (f) Calculate the volume occupied by 20 kg of chlorine gas at a pressure of 100 KPa and 298 K.
- (g) Name any two each of fundamental quantity and derived quantity.

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

- (a) State Dalton's law and Amagat's law. Give their mathematical equations.
- (b) Ammonia is produced by the following reaction : $N_2 + 3 H_2 \rightarrow 2 NH_3$

Calculate :

- (i) Molal flow rate of hydrogen corresponding to nitrogen. Feed rate of 25 k_{mol}/h , if they are fed in the stoichiometric proportions.
- (ii) Kg of NH_3 produced per hour if conversion is 25% and nitrogen feed rate is 25 k_{mol}/h .



- (c) An evaporator is fed with 15000 kg/h of a solution containing 10% NaCl, 15% NaOH and rest water. In the operation, water is evaporated and NaCl is precipitated as crystals. The thick liquor leaving the evaporator contains 45% NaOH, 2% NaCl and rest water.
- (i) Draw the detail block diagram of this operation.
- (ii) Calculate kg/h. of thick liquor
- (d) Explain different types of fuels with example.

3. Attempt any THREE of the following :

12

- (a) Define :
- (i) Yield (ii) Conversion
- (iii) Selectivity (iv) Stoichiometric ratio
- (b) State & explain Hess's law of constant heat summation.
- (c) Convert following pressure values in KPa.
- (i) 100 mm of Hg (ii) 2 atm
- (d) In the production of Sulphur trioxide, 100 k_{mol} of SO₂ and 100 k_{mol} of O₂ are fed to a reactor. If the percent conversion of SO₂ is 80, calculate the composition of product stream on mole basis.

4. Attempt any THREE of the following :

12

- (a) Define :
- (i) Sensible heat (ii) Latent heat
- (iii) Specific heat (iv) Heat of reaction
- (b) 2000 kg of wet solids containing 70%, solid 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 :
- (i) Kg of water removed
- (ii) Kg of dried product obtained
- (c) Explain bypass & recycle operation with block diagram.
- (d) Define gross and net calorific value.

- (e) Convert the following :
- (i) 1000 kg/m³ into gram/cm³
 - (ii) 10 m³/hr. into lit/sec.

5. Attempt any TWO of the following :

12

- (a) A natural gas has the following composition by volume
CH₄ – 82%, C₂H₆ – 12% & N₂ – 6%
Calculate :
- (i) Density of gas at 288 K and 101.325 KPa
 - (ii) Composition in weight percent
- (b) Soyabean seeds are extracted with hexane in batch extractor. The flaked seeds are found to contain 18.6% oil, 69% solid and 12.4% moisture. At the end of process, cake is separated from hexane – oil mixture.
The cake is analysed to contain 0.8% oil, 87.7% solid and 11.5% moisture (by weight).
Calculate the percentage recovery of oil.
- (c) C₂H₄O is prepared by oxidation of C₂H₄, 100 k_{mol} of C₂H₄ and 100 k_{mol} of O₂ are fed to a reactor. The conversion of C₂H₄ is 85% and yield of C₂H₄O is 94.12%. The reactions taking place are
$$\text{C}_2\text{H}_4 + \frac{1}{2} \text{O}_2 \rightarrow \text{C}_2\text{H}_4\text{O}$$
$$\text{C}_2\text{H}_4 + 3 \text{O}_2 \rightarrow 2 \text{CO}_2 + 2 \text{H}_2\text{O}$$

Calculate the composition of product stream leaving the reactor.

6. Attempt any TWO of the following :

12

- (a) Pure ethylene is heated from 303 k to 523 k at atmospheric pressure.
Calculate the heat added per k_{mol} of ethylene using heat capacity data given below.
- $$C_p^\circ = 4.1261 + 155.0213 \times 10^{-3} T - 81.5455 \times 10^{-6} T^2 + 16.9755 \times 10^{-9} T^3$$

P.T.O.

- (b) A combustion reactor is fed with $50 \text{ k}_{\text{mol}}/\text{h}$ of butane and $2000 \text{ k}_{\text{mol}}/\text{h}$ of air. Calculate % excess air used and composition of the gases leaving reactor, assuming complete combustion of butane.
- (c) The waste acid from nitrating process containing 20% HNO_3 , 55% H_2SO_4 & 25% H_2O by weight is to be concentrated by addition of concentrated H_2SO_4 acid containing 95% H_2SO_4 and concentrated HNO_3 acid containing 90% HNO_3 to get desired mixed acid containing 26% HNO_3 & 60% H_2SO_4 . Calculate quantities of waste and concentrated acids required to get 1000 kg of desired mixed acid.
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