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C20-CH –305

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BOARD DIPLOMA EXAMINATION, (C-20)

OCTOBER/NOVEMBER—2023

DCHE – THIRD SEMESTER EXAMINATION

MASS AND ENERGY BALANCE

Time : 3 hours] [*Total Marks* : 80

PART—A 3×10=30

Instructions : (1) Answer **all** questions.

(2) Each question carries **three** marks.

(3) Answers should be brief and straight to the point and shall not exceed five simple sentences.

1. Convert the following into SI units :
(a) 127 Btu/hr ft°F
(b) 475 mm Hg

2. Define *(a)* Dalton's law and *(b)* Amagat's law.

3. Derive the value of 'R' in kJ/kmol K.

4. Draw the block diagram for *(a)* recycle and *(b)* bypass.

5. In the production of SO_3 gas, 100 kmoles of SO_2 and 100 kmoles of O_2 are fed to a reactor. The product stream is found to contain 25 kmoles SO_3. Find the percentage conversion of SO_2.

6. Define *(a)* limiting reactant and *(b)* excess reactant.

7. Define *(a)* selectivity and *(b)* degree of completion.

8. Define *(a)* sensible heat and *(b)* latent heat of vaporization.

9. Distinguish between partial and complete combustion.

10. Define *(a)* theoretical and *(b)* excess air.

PART—B

8×5=40

Instructions : (1) Answer *any* **five** questions.

(2) Each question carries **eight** marks.

(3) Answers should be comprehensive and criterion for valuation is the content but not the length of the answer.

11. *(a)* The heat capacity for carbon dioxide is $C_p = 6{\cdot}339 + 10{\cdot}14\ 10^{-3}T - 3{\cdot}415 \times 10^{-4}T^2$ where C_p = cal/gmole °C and T is in °C. Convert the equation into SI system.

(OR)

(b) An evaporator is maintained under vacuum of 360 mm Hg. Find the absolute pressure in kPa and in bar.

12. *(a)* A solution of caustic soda contains 20% NaOH by weight. Taking the density of solution as 1·196 g/cm^3. Find molarity, normality and molality of the solution.

(OR)

(b) A fuel gas mixture has the following composition by volume C_2H_2=18%, C_2H_4=44% and C_2H_6=38%. Calculate *(i)* Average molar mass of gas mixture, *(ii)* Composition of gas by weight and *(iii)* Density of gas at 288K and 101·325kPa.

13. *(a)* An evaporator system concentrating a weak liquor from 5% to 50% solids handles 100kg of solids per hour. If the same system is to concentrate a weak liquor from 4% to 35%, find 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.

(OR)

(b) 2000 kg 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 *(i)* kg of water removed from wet solids and *(ii)* kg of product obtained.

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

(OR)

(b) 100 kmoles of SO_2 and 50 kmoles of oxygen are fed to the reactor. If the conversion of SO_2 is 75% find *(i)* The moles of SO_2 reacted and *(ii)* Moles of SO_3 formed.

15. *(a)* Calculate the standard heat of reaction of the following reaction.

$$4\ NH_3(g)+5O_2(g) \rightarrow 4NO(g)+6\ H_2O(g)$$

Data : ΔH_F° of NH_3 = –45·94 kJ/mol.

ΔH_F° of NO = +90·25 kJ/mol, H_F° of H_2O = –241·82 kJ/mol.

(OR)

(b) Calculate the enthalpy change between the reactants and the products, if both are at 298K and 10 moles of formaldehyde is produced from methane.

$$CH_4(g)+O_2(g) \rightarrow HCHO(g)+H_2O(g)$$

Data : Heat of combustion of CH_4 = –890·65 kJ/mol, HCHO = –563·46 kJ/mol.

PART—C

10×1=10

Instructions : (1) Answer the following question.

(2) Each question carries **ten** marks.

(3) Answers should be brief and straight to the point and shall not exceed five simple sentences.

16. A flue gas has the following composition by volume :

CO_2 = 13·1%, O_2 = 7·7% and N_2 = 79·2%.

Calculate :

(i) The average molecular weight of the flue gas.

(ii) The weight % composition of the flue gas.

(iii) Density of the flue gas at 50 °C and 2 atmosphere.

(iv) Specific gravity of the flue gas at the same pressure and temperature.

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