CBCS SCHEME

USN | | | | | | | | | | |

18CH32

Third Semester B.E. Degree Examination, June/July 2023
Chemical Process Calculations

Time: 3 hrs. Max. Marks: 100

Note: ***Answer any FIVE full questions, choosing ONE full question from each module.***

Module-1

1 a. The variation of heat capacity data for gaseous SO_2 is given by the following equation :

$C_p = 43.46 + 10.64 \times 10^{-3}\ T - \frac{5.95 \times 10^5}{T^2}$. Where, C_p is in Cal/(g mol) (ºC) and T is in K.

Transform the above equation in FPS units on mole basis. **(10 Marks)**

b. The conductance at a fluid flow system is defined as the volumetric flow rate referred to a pressure of one torr. For an orifice, the conductance C can be computed from the equation.

$C = 89.2\ A\sqrt{\frac{T}{M}}$, Ft^3/s, Where A = Area of Opening , ft^2 ; T = Temperature, ºF ;

M = Molecular weight.

Convert the empirical equation into SI units. **(10 Marks)**

OR

2 a. Starting from the basic show that pressure % = Volume % = Mole %. **(10 Marks)**

b. By electrolyzing a mixed brine, a gaseous mixture is obtained at the cathode having the following composition by weight : $C\ell_2 = 67\%$, $Br_2 = 28\%$ and $\partial_2 = 5\%$.
Calculate : i) Composition of the gas by volume . ii) Average molecular weight.
iii) Density of the gas mixture at 298K and 1 atm. **(10 Marks)**

Module-2

3 a. 10,000 kg/hr of a solution containing 20% methanol is continuously fed to a distillation column. Distillate is found to contain 98% methanol and waste solution from the column carries 1% methanol. All percentage is by weight. Calculate :
i) The mass flow rate of distillate and bottom product.
ii) The percentage loss of methanol. **(10 Marks)**

b. 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. Calculate i) The percentage recovery of solute A.
ii) The fraction of solvent B fed to column lost in gas leaving the tower. **(10 Marks)**

OR

4 a. Explain the concept of material balance equation for steady and unsteady state process. **(10 Marks)**

b. Soyabean seed oil is extracted with hexane in a batch extractor. The flaked seeds contain 18.2% oil , 69.5% solid and 12.3% moisture. At the end of the process, Cake is separated from hexane oil mixture. The Cake analysis yields 0.8% oil, 88.2% solid and 11.0% moisture. All percentage is by weight. Find the percentage recovery of oil. **(10 Marks)**

Module-3

5 a. It is required to make 1000kg of mixed acid containing 60% H_2SO_4 , 32% HNO_3 and 8% water by blending.
i) The spent acid containing 11.3% HNO_3 , 44.4% H_2SO_4 and 44.3% H_2O.
ii) Aqueous 90% HNO_3. iii) Aqueous H_2SO_4 98%.
All percentage is by weight. Calculate the quantities of each of the three acid required for blending. **(10 Marks)**

b. An evaporator system concentrating weak liquor from 10% to 50% solid, handles 200kg of solid per hour. If the same system is to be used to concentrate a weak liquor from 5% to 40%, find the capacity of the system in terms of solids that can be handled per hour assuming water evaporating capacity to be same in both the cases. **(10 Marks)**

OR

6 a. Fresh juice contains 14% solid and 86% water by weight and is to be concentrated to contain 42% solid by weight in a single effect evaporator system. It is found that the volatile constituents of juice escape with water leaving the concentrated juice is 56%, with flat taste. To overcome this problem part of the fresh juice bypasses the evaporator. Calculate
i) The fraction of juice that bypass the evaporator.
ii) The concentrated juice produced containing 42% solid by weight. **(10 Marks)**

b. A continuous fractionating column separate 2000kg/hr of a solution of Benzene and Toluene containing 0.5 mass fraction Benzene into an overhead product containing 0.97 mass fraction Benzene and bottom product containing 0.03 mass fraction of Benzene. A reflux ratio of 2.5kg of reflux per kg of product is to be used. Calculate the quantity of top and bottom product in kg/hr. **(10 Marks)**

Module-4

7 A Coke contain 80% Carbon and 20% non – combustible material by weight.
a. Calculate the amount of O_2 theoretically required to burnt 120kg of Coke completely.
b. If 60% excess air is supplied, calculate the composition of gases in the product stream. **(20 Marks)**

OR

8 Determine the Flue gas analysis and Air – fuel ratio by weight when a medium fuel oil having the following composition : C = 85.7% , H = 10.3% , S = 3.4% , O = 0.5% and Ash = 0.1% is burnt with 30% excess air. All percentage is by weight. Assume that completer combustion takes place. **(20 Marks)**

Module-5

9 a. Explain the concept of Thermo physics and Thermo chemistry. **(08 Marks)**

b. Define Heat capacity, Heat of formation and Heat of reaction. **(06 Marks)**

c. Calculate the standard heat of reaction ΔH_R^0 of the following reaction. **(06 Marks)**

$C_2H_5OH + CH_3COOH \rightarrow C_2H_5OOCH_3 + H_2O$

Component	ΔH_c^0 (kJ/mol)
C_2H_5OH	−1367.69
CH_3COOH	−872.32
$C_2H_5OOCH_3$	−2255.78
H_2O	0

OR

10 a. Explain the concept of Adiabatic Flame temperature. **(06 Marks)**

b. A stream flowing at a rate of 30 kgmol/hr containing 30% (mole) N_2 and 70% (mole) H_2. This is to be heated from 300K to 470K. Calculate the amount of heat transferred using the C_P^0 data given below :

$C_{P_{N_2}}^0 = 29.57 - 5.43 \times 10^{-3}T + 13.17 \times 10^{-6} T^2$. kJ/Kgmol.K.

$C_{P_{H_2}}^0 = 28.65 + 1.02 \times 10^{-3}T - 0.15 \times 10^{-6} T^2$, kJ/Kgmol.K **(14 Marks)**

* * * * *