A **Reg. No. :** | | | | | | | | | | |

Question Paper Code: 93904

B.E./B.Tech. DEGREE EXAMINATION, DEC 2021

Third Semester

Chemical Engineering

19UCH305- CHEMICAL PROCESS CALCULATIONS

(Regulation 2019)

Duration: Three hours Maximum: 100 Marks

Answer ALL Questions

PART A - (10 x 1 = 10 Marks)

1. A cylinder contains 8 gms of He, 40 gms of Ne and 80 gms of Ar. (Molecular weights of the components are 4, 20 and 40 respectively) How many moles of He are there in the cylinder? CO2- AP

(a) 1 (b) 2 (c) 4 (d) 6

2. Which of the following term does not involve in ideal gas law? CO1- U

(a) Pressure (b) Volume. (c) Temperature (d) Time

3. Concept of material balance based upon? CO1- U

(a) Conservation of mass (b) Conservation of energy

(c) Conservation of momentum (d) Conservation of Volume

4. A _____ is one in which material enters and leaves the system without interruption. CO1- U

(a) Continuous process (b) Batch process

(c) Semi-batch process (d) None of the mentioned

5. In humidification the gas is _____ in the liquid for the mass transfer to take part. CO3- Ana

(a) Soluble (b) Insoluble (c) Partially soluble (d) Inert

6. During humidification process the dry bulb temperature _____ CO2- App

(a) increases (b) decreases (c) tends to zero (d) remains the same

7. Change in the internal energy for a steady-state system is always _____ CO1- R

(a) Positive (b) Negative (c) Zero (d) None of the mentioned

8. Heat of formations of A, B, C, and D, are 5 J, 10 J, 15 J, and 20 J respectively, what is the heat of reaction A + 4B -> 3C + D? CO3- Ana

(a) 10 J (b) 20 J (c) 35 J (d) 45 J

9. In presence of which gas is the fuel burnt to generate energy in the form of heat? CO1- U

(a) Oxygen (b) Hydrogen (c) Methane (d) Nitrogen

10. The process of burning fuels in the presence of oxygen is called _____ CO1- R

(a) Induction (b) Ignition (c) Condensation (d) Combustion

PART – B (5 x 2= 10 Marks)

11. 2 litres of NH, at 303 K (30°C) and 20.265 kPa is neutralised by 135 ml of solution of H_2SO_4,. Find the normality of the acid CO4- E

12. What is the purpose of doing mass balance for a chemical process? CO1- R

13. State the term humidification. CO1- R

14. Write the procedure for doing energy balance for a process.. CO1- R

15. What are the three types of fuels available? CO1- R

PART – C (5 x 16= 80 Marks)

16. (a) A gaseous mixture has the following composition by volume : CH_4 = 1 % CO_2 = 8%, CO = 14, O_2 = 6%, H_2O = 1% N_2 = 66% Calculate (i) Average molecular weight of the gas mixture and (ii) Density of the gas mixture at 303 K (30°C) and 101.325 kPa. CO2- App (16)

Or

(b) The analysis of the gas sample is given below (on volume basis) : CH_4 - 66%, CO2 = 30%, NH3 = 4% %Find (a) the average molecular weight of the gas and (b) density of the gas at 202.65 kPa g pressure and 303 K (30°C). CO3- Ana (16)

17. (a) 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. Calculate: (a) kg/h water evaporated, (b) kg/h salt precipitated, (c) kg/h thick liquor. CO2- App (16)

Or

(b) 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 CO2. Calculate: (a) the percent conversion of ethylene and (b) the percent yield of ethylene oxide CO2- App (16)

18. (a) The dry bulb temperature and dew point of ambient air were found to be 302 K (29°C) and 291 K (18°C) respectively. Barometer reads 100 kPa. Calculate: (a) the absolute molal humidity, (b) the absolute humidity, (c) the % RH, (d) the % saturation, (e) the humid heat and (f) the humid volume. CO2- App (16)

Data: Vapour pressure of water at 291 K = 2.0624 kPa.

Vapour pressure of water at 302 K = 4.004 kPa.

Or

(b) The DB and WB temperatures on a particular day in Madurai are observed to be 308 K (35°C) and 299 K (26°C) respectively. Using the psychrometric chart, Find: (a) the absolute humidity (H), (b) % RH, (c) DP.. CO3- Ana (16)

19. (a) Flue gases leaving the boiler stack at 523 K (250°C) have the following composition : CO_2 = 11.31%, H_2O = 13.04%, O_2 = 2.17% and N_2 = 73.48% (by volume) CO2- App (16)

Calculate the heat lost in 1 kmol of gas mixture above 298 K (25°C), using the heat capacity data given below:

$Cp = a + bT + cT2 + dT^3$, kJ/(kmol.K)

Gas	**a**	**b x 10^3**	**c x 10^6**	**d x 10^9**
H_2O	21.3655	64.2841	- 41.0506	9.7999
O_2	26.0257	11.7551	- 2.3426	- 0.5623
CO_2	32.4921	0.0796	13.2107	-4.5474
N_2	29.5909	- 5.141	13.1829	-4.968

Or

(b) A stream flowing at a rate of 10000 mol/h containing 25 mole % N2 and 75 mole % H, is to be heated from 323 K (50°C) to 493 K (220°C). Calculate the heat that must be transferred using Cp data given below: CO4- E (16)

$Cp = a + bT + cT^2 + dT^3$, kJ/(kmol-K)

Gas	**a**	**b x 10^3**	**c x 10^6**	**d x 10^9**
N_2	29.5909	- 5.41	13.1829	-4.968
H_2	28.6105	1.0194	-0.1476	0.769

20. (a) The ultimate analysis of coal sample is given below: Carbon : 61.5%, hydrogen : 3.5%, sulphur : 0.4%, ash : 14.2%, nitrogen : 1.8% and rest oxygen. Calculate : CO2- App (16)

(a) Theoretical oxygen requirement per unit weight of coal.

(b) Theoretical dry air requirement per unit weight of coal, and

(c) The Orsat analysis of flue gases when coal is burned with 90% excess dry air.

Or

(b) The GHV (gross heating value) of gaseous n-butane is 2877.40 kJ/mol at 298 K (25°C). CO2- App (16)

Calculate its NHV (net heating value) in kJ/mol and kJ/kg. = 2442.5 kJ/kg. Latent heat of water vapour at 298 K (25°C)