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Question Paper Code: 54902

B.E. / B.Tech. DEGREE EXAMINATION, MAY 2018

Fourth Semester

Chemical Engineering

15UCH402 - CHEMICAL PROCESS CALCULATIONS

(Regulation 2015)

(Necessary Data book must be provided)

Duration: Three hours

Maximum: 100 Marks

Answer ALL Questions

PART A - (10 x 1 = 10 Marks)

- One mole is defined based on the number of elementary entities present in _____ atom. CO1- R
(a) carbon – 14 (b) carbon – 6 (c) carbon – 12 (d) carbon – 18
- In an ideal gas mixture, the total pressure is the sum of the partial pressures exerted by each component. This is the statement of _____ law. CO1- R
(a) Dalton's (b) Amagat's (c) Vanderwaal's (d) Joule - Thomson
- In material balance equations, the _____ term becomes zero at steady state. CO2- R
(a) input (b) output (c) out – turn (d) accumulation
- A limiting component decides the _____ in the reactions. CO2- R
(a) yield (b) conversion (c) stoichiometric number (d) temperature
- When the partial pressure of the vapor in the gas is the same as the vapor pressure of the substance, then the relative saturation is CO3- R
(a) 0% (b) 50% (c) 30% (d) 100%

6. Sling psychrometer is used to measure _____. CO3- R
 (a) wet – bulb temperature (b) dew point
 (c) humid volume (d) humid heat
7. The ultimate analysis of coal is not used to measure _____. CO4- R
 (a) carbon (b) nitrogen (c) volatile matter (d) sulfur
8. The gas which is present in very low concentration in the flue gases is _____. CO4- R
 (a) CO₂ (b) N₂ (c) SO₂ (d) SO₃
9. The standard heat of reaction is measured at _____. CO5- R
 (a) 100°C and 100 atm (b) 25°C and 1 atm
 (c) 25°C and 10 atm (d) 0°C and 1 atm
10. Compressing a gas in a cylinder is an example for _____ system. CO5- R
 (a) closed unsteady (b) open steady (c) closed steady (d) open unsteady

PART – B (5 x 2= 10Marks)

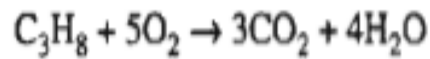
11. Iron metal weighing 500 pounds occupies a volume of 29.25 liters. CO1- R
 Calculate the density of iron in kg/m³.
12. What is recycling operations? Why it is carried out? CO2- R
13. What properties of an air – water vapor mixture are displayed on a humidity chart? CO3- R
14. What is theoretical air and excess air? CO4- R
15. Define heat of formation. CO5- R

PART – C (5 x 16= 80Marks)

16. (a) (i) A saturated solution of salicylic acid in methanol contains 64 kg salicylic acid per 100 kg methanol at 25°C. Find the mass % and mole % composition of the solution. Molecular formula for salicylic acid is HOC₆H₄COOH and for methanol is CH₃OH. CO1- App (8)

- (ii) Explain the calculation of following for aqueous solutions: molarity, molality, normality and concentration in gm/liter. CO1- App (8)
- Or
- (b) Cracked gas from a petroleum refinery has the following composition by volume: $\text{CH}_4 = 45$, $\text{C}_2\text{H}_6 = 10$, $\text{C}_2\text{H}_4 = 25$, $\text{C}_3\text{H}_8 = 7$, $\text{C}_3\text{H}_6 = 8$ and $\text{C}_4\text{H}_{10} = 5$. Find average molar mass of the gas mixture, composition by mass and specific gravity of the gas mixture. (16 marks) CO1- App (16)
17. (a) (i) In a textile mill, a double effect evaporator system concentrates weak liquor containing 4% (by mass) caustic soda to produce a lye containing 25% solids (by mass). Calculate the evaporation of water per 100 kg feed in the evaporator. CO2- App (6)
- (ii) Explain the following terms: limiting reactants, excess reactants, bypass stream and purge stream. CO2- App (10)
- Or
- (b) It is required to make 1000 kg mixed acid containing 60% H_2SO_4 , 32% HNO_3 and 8% water by blending the spent acid (containing 11.3% HNO_3 , 44.4% H_2SO_4 , 44.3% H_2O), an aqueous acid 90% HNO_3 and an aqueous 98% H_2SO_4 . All percentages are by mass. Calculate the quantities of each of the three acids required for blending. (16 marks) CO2- Ana (16)
18. (a) The weather office reports a temperature of 90°F , relative humidity of 85% and a barometric pressure of 14.696 psia. Calculate the following: CO3- Ana (16)
- (i) molal humidity,
(ii) humidity (weight basis) and
(iii) molal humidity and dew point if the air is cooled to 60°F , the pressure remaining steady. Data's: partial pressure of water vapor in gas mixture at $90^\circ\text{F} = 0.6982$ psia.
- Or
- (b) Describe the following terms in humidification operations: humid heat, humid volume, dry bulb temperature and wet bulb temperature. CO3 -U (16)
19. (a) (i) In a combustion test, 20 kg of propane (C_3H_8) is burned with 400 kg of air to produce 44 kg of CO_2 and 12 kg of CO. What CO4- App (8)

was the percent excess air? The reaction involved is:

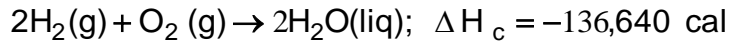
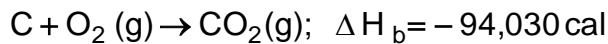
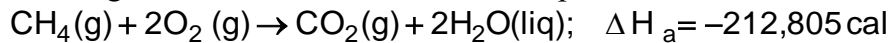


(ii) Explain the principle for Orsat analysis of flue gases. CO4- U (8)

Or

(b) Describe the calculation of heat capacity of gases, solids and liquids. CO4- U (16)

20. (a) (i) Calculate the heat of formation of methane (CH₄) from the following heat of formation of other compound data's: CO5-App (8)



(ii) Write short notes about unsteady state energy balance equations. CO5-U (8)

Or

(b) (i) Discuss the effect of temperature and pressure on heat of reaction. CO5-U (7)

(ii) Explain the applications of energy balance equation without chemical reaction for: closed system, open system with heat transfer and open – steady state flow system. CO5-U (9)