Reg. No. : | | | | | | | | | | |

Question Paper Code: 54092

B.E. / B.Tech. DEGREE EXAMINATION, NOV 2017

Fourth Semester

Chemical Engineering

15UCH402 - CHEMICAL PROCESS CALCULATIONS

(Regulation 2015)

Duration: Three hours Maximum: 100 Marks

Answer ALL Questions

PART A - (10 x 1 = 10 Marks)

1. The value of gas constant (R) in SI system of unit is _____ J/gmole K.

   (a) 0.008205 (b) 1.987 (c) 8.314 (d) 4.184

2. The ratio of the number of moles of a particular compound in a mixture divided by the total number of moles in the mixture is called

   (a) mole fraction (b) specific gravity (c) normality (d) molarity

3. For solving material balances without chemical reaction, _____ material quantity is used which does not change during the operation.

   (a) limiting reactant (b) purged (c) excess reactant (d) tie

4. In chemical processes, a portion of the recycle stream is purged in order to

   (a) maintain constant volume (b) limit the inert concentration
   (c) get mixed type feed (d) prevent the loss of reactants

5. At 100% saturation, which of the following relation is true? (DB = dry bulb temperature, DP = dew point and WB = wet bulb temperature)

   (a) DB = DP = WB (b) DB = DP ≠ WB
   (c) DB ≠ DP = WB (d) DB ≠ DP ≠ WB

6. The ratio of partial pressure of water vapor to the partial pressure of air is called as

   (a) absolute humidity (b) percentage humidity
   (c) saturation humidity (d) molar humidity

7. The ultimate analysis of a fuel is correlated with its calorific value by _____ equation.

(a) Calderwood (b) Clapeyron (c) Dulong (d) Orsat

8. The unit of latent heat is expressed in

(a) J/kg ^{o}K (b) KJ/kg (c) J/ ^{o}K (d) Watt/m^2

9. When the heat of reaction is positive, the reaction is said to be

(a) endothermic (b) reversible (c) exothermic (d) non-elementary

10. The actual flame temperature is always _____ the adiabatic flame temperature.

(a) more than (b) less than (c) equal to (d) 100 ^{o}C greater than

PART - B (5 x 2 = 10 Marks)

11. Find the moles of oxygen present in 100 gm of the O_2 sample.

12. What is "bypass stream"? Why it is important in chemical processes?

13. Define humid volume. Write down the equation to calculate it.

14. Define net calorific value of fuels. Mention its unit..

15. What is the difference between "heat of reaction" and "standard heat of reaction"?

PART - C (5 x 16 = 80 Marks)

16. (a) (i) A solution of HNO_3 in water has a specific gravity of 1.10 at 25^{o}C. The concentration of the HNO_3 is 15 g/L. What is the mole fraction of HNO_3 in the solution. (12)

(ii) Define molarity and molality. (4)

Or

(b) A gas has the following composition at 49^{o}C and 0.93 atm: N_2 = 2 mol%, CH_4 = 79 mol% and C_2H_6 = 19 mol%. What is the partial pressure of each component? What is the volume fraction of each component. (16)

17. (a) It is required to make 1000 kg 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 and (iii) aqueous 98% H_2SO_4. All percentages are by mass. Calculate the quantities of each of the three acids required for blending. (16)

Or

(b) (Explain the concept of limiting reactant and excess reactant with suitable example. (8)

(ii) A sludge (wet solid) containing 70% water and 30% solid is passed through a drier, and the resulting product contains 25% water. How much water is evaporated per 1000 kg of sludge sent to the drier. (8)

18. (a) What is psychrometric chart? Discuss the relationship between dew point, wet bulb and dry bulb temperature, relative humidity, humid volume and adiabatic cooling line using this chart. (16)

Or

(b) Moist air at 100 kPa, a dry bulb temperature of 90^{o}C, and wet bulb temperature of 46^{o}C is enclosed in a rigid container. The container and its contents are cooled to 43^{o}C. (i) What is the molar humidity of the cooled moist air? (ii) What is the final total pressure in atm in the container? (iii) What is the dew point in ^{o}C of the cooled moist air? . At the given dry bulb and wet bulb temperature, humidity is 0.049 kg H_2O / kg air. (16)

19. (a) Explain the following terms involved in combustion process: Orsat analysis, Flue gas, complete combustion, partial combustion, theoretical air and excess air. (16)

Or

(b) Define heat capacity. Explain the determination of average heat capacity for ideal gas mixtures and empirical heat capacity equation for liquids. (16)

20. (a) Explain the effect of temperature and pressure on heat of reaction. (16)

Or

(b) Explain the steps involved in the determination of adiabatic flame temperature in processes that include chemical reactions. (16)

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