KATHMANDU UNIVERSITY
End Semester Examination [C]
April/May, 2023

Marks Scored:

Level : B.E.
Year : II

Course : CHEG 201
Semester : I

Exam Roll No. :

Time: 30 mins.

F. M. : 10

04 APR 2023

Registration No.:

Date :

SECTION "A"
[20Q. × 0.5 = 10 marks]

Encircle the most appropriate answer.

1. In the material balance of a process, which component will not be considered on the input side?
   a. Chemicals b. Water/air c. Recycle d. By product

2. The standard heat of the reaction 2CO → 2C + O2 is given to be 221 kJ/mol. What is the standard heat of formation of CO?
   a. 221 kJ/mol b. -221 kJ/mol c. 111 kJ/mol d. -111 kJ/mol

3. The _____ is the enthalpy change when stoichiometric quantities of reactants at temperature T and pressure P are consumed completely to form products at same T and P.
   a. Heat of mixing b. Heat of reaction
   c. Standard heat of reaction d. Heat of formation

4. The vapor pressure of styrene is 100 mm Hg at 82 °C and 200 mm Hg at 100 °C. A gas containing 10 mol% styrene and 90 mole% non-condensable gas is contained in a tank at 100 °C and 1000 mm Hg. What is the dew point of gas?
   a. 82 °C b. 91 °C
   c. 100 °C d. Not enough information to calculate

5. The vapor pressure of styrene is 100 mm Hg at 82 °C and 200 mm Hg at 100 °C. A gas containing 10 mol% styrene and 90 mole% non-condensable gas is contained in a tank at 100 °C and 1000 mm Hg. What is the relative saturation?
   a. 25% b. 50% c. 100% d. 500%

6. Convert 23 $lb_m.ft/min^2$ to $kg.cm/s^2$.
   a. 0.088 b. 0.092 c. 0.188 d. 0.232

7. The Reynolds number is a dimensionless number given by equation $R = D*v*\rho/\mu$. If D has units of m, v has units of m/s and ρ has units of kg/m^3, what is the unit of μ?
   a. No units b. m/s^2 c. kg.m/s d. kg/m.s

8. A solution contains 15% A by mass and 20 mole% B. What is the total solution flow rate if the flow rate of B is 28 kmol/s?
   a. 100 kmol/s b. 140 kmol/s c. 155 mol/s d. 1800 mol/s

9. What would be the molecular weight of air if it contained 48% N_2 and 52% O_2?
   a. 28 b. 29 c. 30 d. 32

10. A 0.5 M aqueous solution of sulfuric acid flows into a process unit at a rate of 1.25 m^3/min. The specific gravity of the solution is 1.03. What is the mass flow rate of the solution?
a. 1.24 kg/s b. 21.46 kg/s c. 49.92 kg/s d. 51.23 kg/s

11. Each year 500 people move into a city, 750 people move out, 220 are born and 190 people die. What is the population balance of the city?
a. -220 people b. -250 people c. 110 people d. 200 people

12. Two reactants A (200 kg) and B (200 kg) are mixed together for a process. The reactants react in equal proportion and 50% conversion is achieved. The weight of the product formed is
a. 150 kg b. 200 kg c. 250 kg d. 400 kg

13. In a coal fired boiler, hourly consumption of coal is 1000 kg. The ash content in the coal is 3%. How much ash is formed per day if the boiler operates 24 hrs/day?
a. 33 kg b. 50 kg c. 300 kg d. 720 kg

14. In a drying process, moisture is reduced from 60% to 30%. If the initial weight of the material is 200 kg, what is the final weight of the product to the nearest whole number?
a. 100 b. 114 c. 120 d. 140

15. The total energy of a stationary system is equivalent to:
a. The internal energy of the system
b. The kinetic energy of the system
c. The potential energy of the system
d. The sum of kinetic, potential and internal energies of the system

16. The higher the vapor pressure at a given temperature, the greater the _____ of the species at that temperature.
a. Critical temperature b. Triple point
c. Volatility d. Latent heat

17. The mathematical relation used to estimate the vapor pressure is called
a. Antoine's equation b. Raoult's law
c. Henry's law d. Hess's law

18. Which of the following in **NOT** an intensive variable?
a. Temperature b. Density c. Specific volume d. Volume

19. If the partial pressure of a vapor in equilibrium with a gas mixture containing a single condensable component is equal to the vapor pressure of the pure component at system T, any attempt to increase the partial pressure will lead to _____.
a. Sublimation b. Boiling c. Condensation d. Saturation

20. _____Law is often applied to solutions of non-condensable gases.
a. Raoult's b. Henry's c. Hess's d. Antoine's

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Level : B.E.
Year : II
Time : 2 hrs. 30 mins.

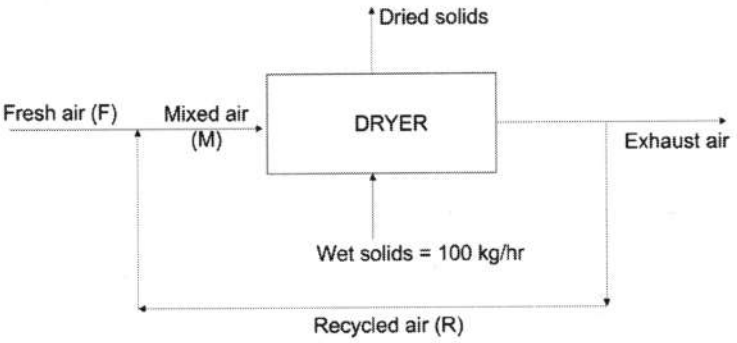
Course : CHEG 201
Semester : I
F.M. : 40

SECTION "B"
[40 marks]

Attempt *ALL* questions

1. Consider a furnace where methane is mixed with 50% of excess air for the conversion of limestone into lime by a thermal process.
   a. Write the equations for the combustion of methane and conversion of limestone to lime. [2]
   b. If 24.5 kg of lime is produced per kg of methane burned, calculate the molar flow of inputs and outputs of all components for the system. [3]

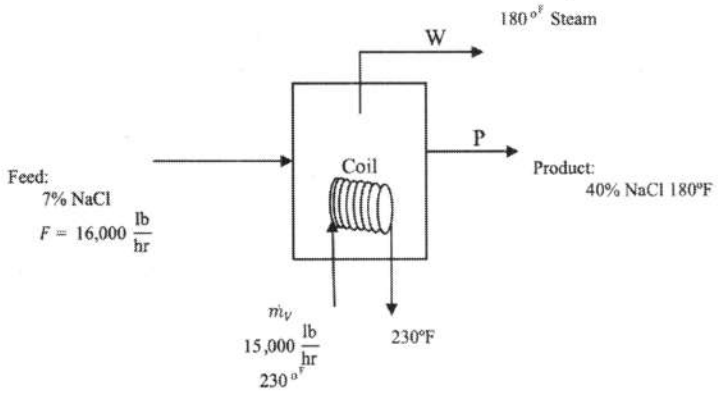
2. A dryer is used to dry 100kg/h wet solids (wood) from 20% to 1% moisture (by weight) by fresh air. The fresh air containing 1.96% moisture (water) is available for drying. The air exiting the dryer contains 9.1% moisture in it. The ratio of dry air in recycle to dry air in fresh air is given to be 3.
   a. Calculate the amount of water lost by the solids. [2]
   b. Calculate the % of moisture in the mixed air. [3]
   c. Calculate the amount of mixed air. [3]



3. Air as a coolant is injected into a cooling tower with a flow rate of 100,000 m^3/hr. Air enters the system at 28 °C but its wet bulb is 19 °C. The exit air temperature is 36 °C and its wet bulb is 32 °C. The temperatures of water at the inlet and outlet are 50 and 30 °C respectively. How much water is cooled in the cooling tower? [5]

4. A gas mixture consisting of 15 mole% benzene, 10 mole% toluene and 75 mole% nitrogen (consider nitrogen non-condensable) is compressed isothermally at 80 °C until condensation occurs. Calculate the system pressure and the composition of the initial condensate. [5]

5. 16000 lb/hr of NaCl solution with a concentration of 7% is concentrated to 40% in an isolated evaporator using a steam coil as shown in the figure below. The feed is separated from steam and leaves the evaporator at 180 °F. 15000 lb/hr of saturated heating steam is injected into a coil at 230 °F and leaves the coil as saturated liquid at the same temperature.



The Cp values for 7% NaCl solution and 40% NaCl solution are given to be 0.92 and 0.85 Btu/lbm.°F respectively.

a. Find the values for W and P. [3]
b. Write the energy balance equation for the system. [2]
c. Calculate the feed temperature. [5]

6. The analysis of a gas mixture showed 30% O_2, 40%N_2, 10% CO_2 and 20% CH_4. The gas mixture is at 8 MPa and 15 °C and flows through a 2 cm diameter pipe at a speed of 3 m/s. Calculate the mass flow rate of the gas. [7]