Assignment 6
Single-Phase Systems & Multiphase Systems
Chap. 5 and 6

Instruction : Write down the basis of calculation and assumptions (if any) clearly. Box the final answer (s)

CHAPTER 5

1. A steel container has a volume of 200 m^3. It is filled with nitrogen at 22°C and atmospheric pressure. If the container valve is opened and the container is heated to 200°C, calculate the fraction of the nitrogen which leaves the container. *(0.38)*
2. 20 ft^3 of nitrogen at 300 psig and 100 ^oF and 30 ft^3 of oxygen at 200 psig and 340 ^oF are injected into a 15 ft^3 vessel. The vessel is then cooled to 70 ^oF. Find the partial pressure of each component in the 15 ft^3 vessel. Assume that the ideal gas law applies. *(N_2= 396 psia, O_2=286psia)*
3. A gas analyzes 60% methane and 40% ethylene by volume. It is desired to store 12.3 kg of this gas mixture in a cylinder. The maximum temperature and pressure of 45°C and 26 MPa, respectively. Calculate the volume of the cylinder in m^3 using the compressibility factor determined by the Kay's rule. *(0.051 m^3)*.
4. A gas composed of 80% CO_2 and 20% ethanol is at 500K. What is the pressure if the volume per gmol is 180 cm^3/gmol? *(177 atm)*
5. A gas mixture containing 85% methane, 12% ethane and the balance carbon dioxide by volume is stored in a 35-liter tank at 3000 psig and 30^{o}C.
   a. Calculate the theoretical volume (m^3) of combustion air at atmospheric condition. (Assuming atmospheric pressure and temperature are 760mm Hg and 30^{o}C, respectively). *(89.35 m^3)*
   b. Assuming complete combustion of stoichiometric proportion of fuel and air mixture, calculate the volume (m^3) of the flue gases at STP. *(89.2 m^3)*

CHAPTER 6

1. Liquid acetone and air are kept in a tank in a ratio of 3:1 by mass and heated in a tank until all acetone becomes vapor. Nitrogen saturated with acetone vapor leaves the tank in equilibrium at 1 atm. Calculate the temperature of the gas mixture and its molar composition*.(41.5^{o}C, Y_{Ac}=0.591 mol N2/mol)*
2. Air at 90°C and 1.00 atm (absolute) contains 10.0mole% water. This stream of air enters a compressor—condenser, in which the temperature is lowered to 15.6°C and the pressure, is raised to 3.00 atm. The air leaving the condenser is then heated isobarically to 100°C. Calculate the fraction of water that is condensed from the air and the ratio m^3 outlet air at 100°C/m^3 feed air at 90°C. *(0.947 mol condensed/mol feed; 0.31 m^3 outlet air/m^3 feed air)*
3. Wet air at 27^{o}C and 1 atm contains 2.6 mol% water vapor. We need to feed the air at 1000 kmol/h into a reactor, but the air must contain at most 0.6 mol% water vapor. You propose to remove the water by condensation.

a. Calculate the condenser temperature and the percentage of water condensation. Assume the pressure drop across the condenser is negligible. *(0^oC, 77.35%)*

b. Referring to question 3, determine the operating pressure if the condensation is achieved by isothermal compression. *(4450 mm Hg)*

4. A stream of mixture containing 20 mol% ethanol and 80 mol% water is fed to a flash drum operating at 760 mm Hg. The feed rate is 100 kmol/h. The mixture is heated until the system is in equilibrium at 95^oC. The vapor and liquid products are removed continuously. Calculate the flow rate and composition of vapor and liquid products. *(V=28.75 kmol/h, L=71.25 kmol/h, Y_{etOH}=30mol%, X_{etOH}=16 mol%)*

5. 100 mol/h of an unknown composition of methanol/water liquid mixture is fed to an equilibrium flash tank operating at 77 ^oC. The system conditions are such that 50% of the entering feed is vaporized and the vapor product leaving the tank contains 80 mol% methanol. Determine the mol factions of methanol and water in the liquid stream leaving the tank, and the pressure (atm) at which the tank operates and the molar composition (mol%) of the feed mixture) . *(X_m= 0.508 mol CH_3OH/mol and X_w= 0.492 mol H_2O/mol, P=772.8 mm Hg, Feed composition : 65.4 mo% CH_3OH and 34.6 mol% H_2O)*