TUTORIAL-6 (19 Mar 2019)
Thermodynamics for Aerospace Engineers (AS1300)

1. Show that for an engine cycle, the areas of the full curve in TS diagram of the cycle and the PV diagram of the curve are equal. Will it be true for a refrigeration cycle as well?

2. A refrigerator operates between two systems A and B. System A is a very large reservoir with tempetature T_A. System B is finite and is to be maintained at T_B, which is less than T_A. If systems A and B are separated by a heat conducting wall with conductivity '*k*', and thickness 'δ_w' then find the minimum steady state power consumption to maintain these temperatures. What is the entropy generated in this case.

3. A tank had water and air inside at 1 bar pressure. The air volume at 25 deg C was 0.2 m^3. The water mass was 0.5 kg at the beginning. But due to evaporation, 2 grams of air went into vapor phase, without change in temperature of the gases. Find the mole fraction and mass fraction of water in air. Assume that the pressure does not change much due to evaporation.

4. A gaseous mixture has the following composition by mass: CH_4: 58%, H_2: 18%, CO: 14%, N_2: 10%. Given that the *molar* constant pressure specific heat values of these gases are:
$C_{P,CH4}$ = 35.06 kJ/(kmol K), $C_{P,H2}$ = 29.01 kJ/(kmol K), $C_{P,CO}$ = 28.88 kJ/(kmol K) and $C_{P,N2}$ = 28.87 kJ/(kmol K), find the following: (a) molecular weight of the mixture (b) gas constant of the mixture, and (c) C_P and C_V values in kJ/kg for the mixture.

5. A vessel is initially divided into three parts by two partitions. Part 1 contains H2 of volume 0.1 m3. Part 2 contains N2 of volume 0.2 m3, and Part 3 contains CO2 of volume 0.05 m3. All the parts are at p= 2 bar and T=13 deg C. First, partitions are removed and the gases are allowed to mix thoroughly. Later, the mixture is reversibly compressed to a pressure of 6 bar following $Pv^{1.2}$=constant.
C_p of H2, N2 and CO2 are 14.235, 1.039 and 0.828 kJ/(kg K), respectively.
Determine (a) Molecular weight of the mixture, (b) specific gas constant of the mixture, (c) Partial pressures of each gas, (d) γ of the mixture, (e) entropy change due to mixing, (f) work and heat interactions due to the compression process, and (g) entropy change due to compression.

Problems to be solved by TMM in class

1. Two tanks are connected by a valve. one tank contains 2 kg of CO at 77 deg C and 0.7 bar. The other tank holds 8kg of the same gas at 27 deg C and 1.2 bar. The valve is opened and the gases are allowed to mix while receiving energy by heat transfer from the surroundings. The final equilibrium temperature is 42 deg C. Determine the final equilibrium pressure and the heat transfer for the process.

2. A vessel of volume 2V is divided into two equal parts. These are filled with the same ideal gas, with states, (P1, T1) and (P2, T2). The gases are allowed to mix slowly with no heat transfer. Find the final pressure, Temperature and Entropy gain.