CANKAYA UNIVERSITY
FACULTY OF ENGINEERING AND ARCHITECTURE
MECHANICAL ENGINEERING DEPARTMENT
ME 212 THERMODYNAMICS II

CHAPTER 12

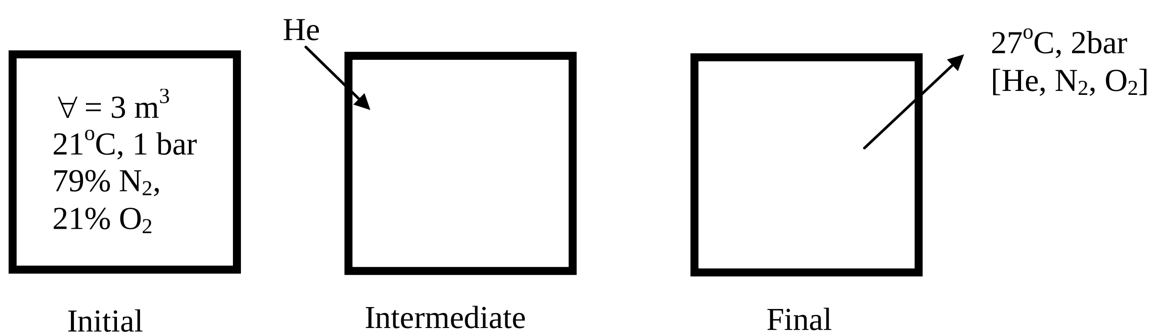
EXAMPLES

2) The molar analysis of a gas mixture at 30°C, 2 bar is 40% N_2, 50% $C0_2$, and 10% CH_4.

Determine;

a) the analysis in terms of mass fractions.
b) the partial pressure of each component, in bar.
c) the volume occupied by 10 kg of mixture, in m^3.

3) A rigid vessel having a volume of 3 m^3 initially contains a mixture at 21°C, 1 bar consisting of 79% N_2 and 21% O_2 on a molar basis. Helium is allowed to flow into the vessel unit the pressure 2 bar. If the final temperature of the mixture within the vessel is 27°C, determine the mass, in kg, of each component present.



4) Let a mass m_A of ideal gas A at given pressure and temperature, p and T, be mixed with m_B of ideal gas B at the same p and T, such that the final ideal gas mixture is also at p and T. Determine the change in entropy for this process.

5) Two kg of a mixture having an analysis on a mass basis of 30% N_2, 40% CO_2, 30% O_2 is compressed adiabatically from 1 bar, 300 K to 4 bar, 500 K. Determine;

a) the work, in kJ.
b) the amount of entropy produced, in kJ/K.

6) A mixture having a molar analysis of 50% CO_2, 33.3% CO, and 16.7% O_2 enters a compressor operating at steady state at 37^oC, 1 bar, 40 m/s with mass flow rate of 1 kg/s and exits at 237^oC, 30 m/s. The rate of heat transfer from the compressor to its surroundings is 5% of the power input.

a) Neglecting potential energy effects, determine the power input to the compressor, in kW.
b) If the compression is polytropic, evaluate the polytropic exponent 'n' and the exit pressure, in bar.

7) An insulated tank has two compartments connected by a valve. Initially, one comportment contains 0.7 kg of CO_2 at 500 K, 6.0 bar and the other contains 0.3 kg of N_2 at 300 K, 6.0 bar. The valve is opened and the gases are allowed to mix until equilibrium is achieved. Determine:
a) the final temperature, in K.
b) the final pressure, in bar.
c) The amount of entropy produced, in kJ/K.

8) Consider 100 m^3 of an air-water vapor mixture at 0.1 MPa, 35^oC, and 70% relative humidity. Calculate the humidity ratio, dew point, mass of air, and mass of vapor.

9) Consider 100 m^3 of an air-water vapor mixture at 0.1 MPa, 35^oC, and 70% relative humidity. Calculate the amount of water vapor condensed if the mixture is cooled to 5^oC in a constant pressure process.

10) A tank has a volume of 0.5 m^3 and contains nitrogen and water vapor. The temperature of the mixture is 50^oC, and the total pressure is 2 MPa. The partial pressure of the water vapor is 5 kPa. Calculate the heat transfer when the contents of the tank are cooled to 10^oC.

11) A closed, rigid tank initially contains 0.5 m^3 of moist air in equilibrium with 0.1 m^3 of liquid water at 80^oC and 0.1 MPa. If the tank contents are heated to 200^oC, determine;

a) the final pressure, in MPa.
b) the heat transfer, in kJ.

12) A closed, rigid tank having a volume of 1 m^3 contains a mixture of CO_2 and water vapor at 75^oC. The respective masses are 12.3 kg of CO_2 and 0.05 kg of water vapor. If the tank contents are cooled to 20^oC, determine the heat transfer, in kJ, assuming ideal gas behavior.

13) An air-conditioning unit is shown in figure, with pressure, temperature, and relative humidity data. Calculate the heat transfer per kg of dry air, assuming that changes in kinetic energy are negligible.

14) The pressure of the mixture entering and leaving the adiabatic saturator is 0.1 MPa, the entering temperature is 30^oC, and the temperature leaving is 20^oC, which is the adiabatic saturation temperature. Calculate the humidity ratio and relative humidity of the air-water vapor mixture entering.

15) Saturated air leaving the cooling section of an air-conditioning system at 14^oC at a rate of 50 m^3/min is mixed adiabatically with the outside air at 32^oC and 60 percent relative humidity at a rate of 20 m^3/min. Assuming that the mixing process occurs at a pressure of 1 atm, determine the specific humidity, the relative humidity, the dry-bulb temperature, and the volume flow rate of the mixture.

16) At steady state, 100 m^3/min of dry air at 32 ^oC and 1 bar is mixed adiabatically with a stream of oxygen (O_2) at 127 ^oC and 1 bar to form a mixed stream at 47 ^oC and 1 bar. Kinetic and potential energy effects can be ignored. Determine

(a) the mass flow rates of the dry air and oxygen, in kg/min, **(16p)**

(b) the mole fractions of the dry air and oxygen in the exiting mixture. **(12p)**

(c) the time rate of entropy production, in kJ/K.min. **(7p)**