Homework #3

MEMS 0051 - Introduction to Thermodynamics

Assigned January 25th, 2019
Due: February 1st, 2019

Problem #1

Please refer to the Saturated Water tables.

a) Determine the quality of water at the following states:
   i.) T=150 °C, ν=0.285 [m^3/kg]
   ii.) P=500 [kPa], ν=0.285 [m^3/kg]
   iii.) P=800 [kPa], ν=0.61813 [m^3/kg]
   iv.) T=100 °C, ν=0.001020 [m^3/kg]

b) Determine the specific volume and specific internal energy of water at the following states:
   i.) P=200 [kPa], x=0.5
   ii.) T=300 °C, x=0.5
   iii.) P=523 [kPa], x=0.5
   iv.) T=72 °C, x=0.5

c) Determine the specific internal energy of water for the states listed in part a.

Problem #2

a) 100 [kg] of C_2H_4 is contained in a 3 [m^3] vessel at 300 °K.
   i.) Calculate the gas constant, R, for C_2H_4 based on its molecular mass listed in Table A.5.
   ii.) Determine how many moles, n, of C_2H_4 are in the vessel.
   iii.) What is the pressure of C_2H_4 in the vessel?

b) Heat is now added to the vessel until it reaches a temperature of 500 °K.
   i.) Is the specific volume of C_2H_4 constant during this process? Why or why not?
   ii.) What is the final pressure in the vessel?
   iii.) Calculate the reduced pressure, P_r, of C_2H_4 <u>after</u> being heated.
   iv.) Calculate the reduced temperature, C_2H_4 T_r, of <u>before</u> being heated.
   v.) Can we assume that C_2H_4 behaved like an ideal gas throughout this process? Why or why not?

Problem #3

a) Consider 2 [kg] of saturated R-134a vapor contained in a piston-cylinder apparatus. The vapor temperature is -52 °C.
   i.) What is the total internal energy, U, of the R-134a vapor at this state?
   ii.) What is the pressure of R-134a vapor at this state?
   iii.) What volume is occupied by the R-134a vapor? (*Hint: look up the specific volume*)

b) An external force now pushes down on the piston, compressing the vapor isobarically until it reaches a final volume of 1.0 [m^3].
   i.) What is the specific volume of the saturated R-134a mixture now?
   ii.) What is the quality of the saturated R-134a mixture?
   iii.) What is the total internal energy of both phases (U_f+U_g) in this final state?
   iv.) How much work was **<u>done by</u>** the piston in this process? (Note: W=P($\forall_2$-$\forall_1$) for constant pressure processes).
   v.) How much heat was **<u>transferred into</u>** the saturated R-134a during this process?