

Homework #3

MEMS 0051 - Introduction to Thermodynamics

Assigned January 26th, 2018

Due: February 2nd, 2018

Problem #1

Please refer to the Saturated Water tables.

- a) Determine the quality of water at the following states:
 - i.) $T=115\text{ }^{\circ}\text{C}$, $\nu=0.4\text{ [m}^3/\text{kg]}$
 - ii.) $P=250\text{ [kPa]}$, $\nu=0.25\text{ [m}^3/\text{kg]}$
- b) Determine the specific volume of water at the following states:
 - i.) $P=100\text{ [kPa]}$, $x=0.7$
 - ii.) $T=90\text{ }^{\circ}\text{C}$, $x=0.4$

Problem #2

- a) 100 [kg] of CO_2 is contained in a 2 [m³] vessel at 25 °C.
 - i.) Calculate the gas constant, R , for CO_2 based on its molecular mass listed in Table A.2.
 - ii.) Determine how many moles, n , of CO_2 are in the vessel.
 - iii.) What is the pressure of CO_2 in the vessel?
- b) Heat is now added to the vessel until it reaches a temperature of 200 °C.
 - i.) Is the specific volume of CO_2 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 CO_2 after being heated.
 - iv.) Calculate the reduced temperature, T_r , of CO_2 before being heated.
 - v.) Can we assume that CO_2 behaved like an ideal gas throughout this process? Why or why not?

Problem #3

- a) Consider 1 [kg] of saturated water vapor contained in a piston-cylinder apparatus. The vapor temperature is 100 °C.
 - i.) What is the total internal energy, U , of the water vapor at this state?
 - ii.) What is the pressure of water vapor at this state?
 - iii.) What volume is occupied by the water 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 1.2 [m³].
 - i.) What is the specific volume of the saturated water mixture now?
 - ii.) What is the quality of the saturated water mixture?
 - iii.) What is the total internal energy of both phases (U_f+U_g) in this final state?
 - iv.) How much work was done by the piston in this process? (Note: $W=P(\forall_2-\forall_1)$ for constant pressure processes).
 - v.) How much heat was transferred into the saturated water during this process?