Homework #8

MEMS 0051 - Introduction to Thermodynamics

Assigned March 24^{th}, 2019
Due: March 29^{th}, 2019

Problem #1

In a reversible process, N_2 is compressed in a cylinder from 100 [kPa] and 20 [°C] to 500 [kPa]. During this compression process, the relation between pressure and volume is $P\forall^{1.3}$ = constant. Calculate the work and heat transfer per kilogram.

Problem #2

A hydrogen gas in a piston/cylinder assembly at 280 [K], 100 [kPa] with a volume of 0.1 [m^3] is now compressed to a volume of 0.01 [m^3] in a reversible adiabatic process. What is the new temperature and how much work is required.

Problem #3

Liquid R-134a refrigerant undergoes a process from 0 [°C] and 1,000 [kPa] to 20 [°C] and 5,000 [kPa]. Determine the change in specific entropy for this process using:

a) tabulated values.
b) TdS equations for in-compressible substances.

Problem #4

A 0.5 [kg] metal bar initially at 1200 [K] is removed from an oven and quenched by immersing it in a closed tank containing 0.9 [kg] of water initially at 300 [K]. Each substance can be assumed to be in-compressible. An appropriate constant specific heat for the water is 4.2 $\left[\frac{\text{kJ}}{\text{kg-K}}\right]$ and an appropriate constant specific heat for the metal is 0.42 $\left[\frac{\text{kJ}}{\text{kg-K}}\right]$. Assume the tank is well insulated (e.g no heat entering or leaving the tank). Determine the following:

a) The final equilibrium temperature of the metal and the water
b) Entropy generated

Problem #5

One kilogram of O_2 modeled as an ideal gas undergoes a process from 300 [K], 2 bar to 1500 [K], 1.5 bar. Determine the change in specific entropy using:

1. Constant specific heats in Table A.5
2. Standard entropy in Table A.8
3. Specific heat as a function of temperature in Table A.6 evaluated at 900 [K]

Problem #6

Hot combustion air at 1500 [K] expands in a polytropic process to a volume six times as large with n = 1.5. Find the specific boundary work and the specific heat transfer.