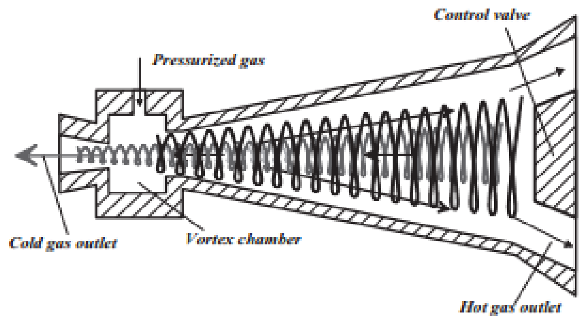
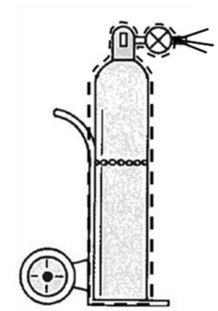
Homework – Week 12 | **ME 200 – Thermodynamics I** | Due by 11:59 pm EDT
Submit on Gradescope | *Spring 2020* | on April 9, 2020

HW – 30: More Entropy Generation Problems

i) An engineer has developed a steady-state, steady-flow device shown in the diagram that takes air at a pressure and temperature of 30 bar and 310 K, splits it into two equal flow rates that are each at a pressure of 2 bar but at different temperatures of 390 K and 210 K. The surrounding environmental temperature is at 300 K. Evaluate whether the stated operating conditions are thermodynamically possible.



ii) Consider HW-19ii where the 5-gallon tank of R134a develops a slow leak at the top of the tank into a room at 20°C and 100 kPa. Using relevant given (x_1=0.1, x_2=1.0, and an isothermal process) and calculated conditions from the posted solution as given information for this problem, determine the total entropy generation, in kJ/K. Be sure to follow the formal solution procedure, but only include a system definition, assumptions and basic equations that are relevant to this part of the problem. You should consider that the leakage occurs through a leaky valve at the top of the tank and behaves like a typical throttling process.



HW – 31: Isentropic Processes and Efficiencies

i) Air at 200 kPa and 950 K enters an adiabatic nozzle at low velocity and is discharged at a pressure of 80 kPa. Determine (*a*) the maximum possible exit velocity, (*b*) the minimum possible exit temperature, and (*c*) the exit velocity and temperature of the air for an isentropic efficiency of 92 percent. Depict the ideal and actual processes on a T-s diagram.

ii) Steam enters an adiabatic turbine at 8 MPa and 520°C with a mass flow rate of 3 kg/s and leaves at 30 kPa. The isentropic efficiency of the turbine is 0.90. Determine (a) the temperature at the turbine exit and (b) the power output of the turbine. Depict the process on a T-s diagram along with appropriate lines of constant pressure.

iii) Air is compressed using a steady-state, steady-flow and adiabatic compressor from 95 kPa and 27°C to 600 kPa and 277°C. Assuming variable specific heats, determine (a) the isentropic efficiency of the compressor and (b) the exit temperature of air if the process is reversible. Depict the actual and reversible processes on a T-s diagram along with appropriate lines of constant pressure.

HW – 32: Reversible Steady Flow Processes

i) A steady-state, steady flow air compressor is cooled such that the air undergoes a polytropic process where $Pv^{1.1} = constant$. The inlet state is 100 kPa and 300 K and the outlet pressure 1 MPa. Assuming the compressor is internally reversible, determine the following quantities per unit mass of flow: (*a*) specific work in kJ/kg, (*b*) exit temperature in K, and (*c*) heat transfer in kJ/kg. Depict the process on a T-s diagram along with appropriate lines of constant pressure.

ii) A non-adiabatic and steady-state, steady flow water pump has an inlet temperature and pressure of 20°C and 100 kPa and an outlet pressure and temperature of 600 kPa and 18°C. Assuming the pump is internally reversible, determine the following quantities per unit mass of flow: (*a*) specific work in kJ/kg and (*b*) heat transfer in kJ/kg.