Chapter 6 Examples (Entropy)

1. A heat engine receives 600 kJ heat from a high temperature heat reservoir at 1000 K. It converts 150 kJ of this heat into work and rejects the rest to a sink at 300 K. Determine whether this engine is reversible, irreversible or impossible using
   a. Carnot Principles
   b. Clausius Inequality

2. A rigid tank contains 2 kg of CO_2 at 10 bar and 80ºC. It is cooled until the pressure reaches 8 bar. Assuming ideal gas behavior, determine the entropy change during the process. R=0.189 kJ/kg.K and c_v=0.657 kJ/kg.K

3. 1 kg of air is at 2.3 bar, 62ºC. With an adiabatic process, can 1.4 bar, 10ºC be reached?

4. An adiabatic tank is divided into two sections by a wall. The wall is fixed and it allows heat transfer between both sides. One section contains 2 kg of Helium at an initial condition of 10 bar, 400 K while the other side contains 3 kg of Oxygen at an initial condition of 5 bar, 600 K. The system is allowed to reach thermal equilibrium. Calculate the entropy generated during the process. (Helium; R=2.0769kJ/kg.K, c_v=3.1156kJ/kg.K, Oxygen; R=0.2598kJ/kg.K, c_v=0.658kJ/kg.K)

5. Steam flows steadily through a turbine. It enters at 30 bar, 400ºC and a speed of 160 m/s and leaves as saturated steam at 100ºC and a speed of 100 m/s. 540 kJ/kg of work is produced while some heat is lost through the wall at 500 K. Calculate the entropy generated.

6. Air at 327ºC, 400 kPa with a volumetric flow rate of 1 m^3/s enters an adiabatic turbine and exits at 100 kPa. Neglecting KE and PE, and taking R=0.287 kJ/kg.K, c_p=1.005 kJ/kg.K, determine
   a. the lowest possible exit temperature and the rate of entropy generation
   b. the highest possible exit temperature and the rate of entropy generation.

7. Two steady flows of steam enters an adiabatic device at the same temperature of 300ºC. The first flow is at 20 bar with a flowrate of 100 kg/jam. While the second flow is at 5 bar with a flowrate of 50 kg/jam. This system produces a net work. Steam exits via a third channel at 2 bar.
   a. Sketch and label the system and the flows.
   b. What is the criteria for maximum work.
   c. Find the maximum work (power) generated (kW).

8. Argon enters an adiabatic turbine at 800ºC, 1.5 MPa with a flow rate of 80 kg/min and exits at 200 kPa. If the turbine power output is 370 kW, find the isentropic efficiency of the turbine.