Chapter 8 — Entropy Production and Accounting

1. Define, illustrate, and explain the following terms and concepts:

   Second Law of Thermodynamics

   Reversible processes
      internally *reversible* vs internally *irreversible*

   Entropy
      units: kJ/K ; Btu/°R
      specific entropy: *s*
         units: kJ/(K·kg); Btu/(°R·lbm)

   Thermodynamic temperature

   Application of Accounting Principle for Entropy

      rate of accumulation of entropy within the system
         amount of entropy within the system: $S_{sys} = \int_V s\,\rho dV$

      transport rate of entropy across system boundaries
         transport rate of entropy by heat transfer: $\sum \frac{\dot{Q}_j}{T_{b,j}}$
         transport rate of entropy by mass flow: $\sum_{in} \dot{m}_i s_i - \sum_{out} \dot{m}_e s_e$

      production/consumption of entropy
         EMPIRICAL EVIDENCE ---- Entropy can only be produced and in the limit of an internally reversible process entropy is conserved.

         Rate of entropy production:

$$\dot{S}_{gen} \begin{cases} > 0 & \text{Internally irreversible} \\ = 0 & \text{Internally reversible} \end{cases}$$

   Accounting Equation for Entropy

      rate form: $$\frac{dS_{sys}}{dt} = \sum \frac{\dot{Q}_j}{T_{b,j}} + \sum_{in} \dot{m}_i s_i - \sum_{out} \dot{m}_e s_e + \dot{S}_{gen}$$

   Carnot Efficiency for a Power Cycle

   Isentropic Processs

2. Apply the accounting equation for entropy in conjunction with the conservation of energy equation to calculate the entropy generation rate or entropy generation for a steady-state device or cycle.

3. Given sufficient information, determine the specific entropy change Δs for a substance when one of the following models apply:
   Ideal gas with room-temperature specific heats
   Incompressible substance with room-temperature specific heats

4. Apply the entropy accounting equation in conjunction with the conservation of energy equation to calculate the entropy generation or the entropy generation rate for a system when all other necessary information is known

5. Apply the accounting equation for entropy in conjunction with the conservation of energy equation to determine the theoretical "best" performance, i.e. theoretical maximum thermal efficiency or coefficient of performance for a cycle.

6. Determine if a specific device or system is operating in a reversible fashion, an irreversible fashion, or is not physically possible.

7. Evalute the performance of a device or system when it is operating in an internally reversible fashion.