

OBJECTIVES -- Entropy Accounting & The Second Law of Thermodynamics

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)

Application of Accounting Principle for Entropy

rate of accumulation of entropy within the system

amount of entropy within the system: $S_{sys} = \int_V s \mathbf{r} dV$

transport rate of entropy across system boundaries

transport rate of entropy by heat transfer: $\sum \frac{\dot{Q}_j}{T_j}$

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:
$$\frac{dS_{sys}}{dt} = \sum \frac{\dot{Q}_j}{T_j} + \sum_{in} \dot{m}_i s_i - \sum_{out} \dot{m}_e s_e + \dot{S}_{gen}$$

2. Apply the accounting equation for entropy in conjunction with the conservation of energy equation to calculate the entropy generation or the entropy generation rate for a system when all required entropy values are known or suitable property models are specified, e.g. ideal gas or incompressible substance.
3. Given sufficient information, determine the specific entropy change Δs for a substance when one of the following substance models apply:
- Ideal gas with constant specific heats,
 - Incompressible substance with constant specific heats.

4. Apply the accounting equation for entropy in conjunction with the conservation of energy equation to calculate the entropy generation rate or entropy generation for steady-state device or cycle.
5. Apply the accounting equation for entropy in conjunction with the conservation of energy equation to determine “best” possible performance, i.e. theoretical maximum thermal efficiency or coefficient of performance, for a cycle.