ES 202
Fluid and Thermal Systems

Lecture 21:
Isentropic Efficiencies
(1/30/2003)

Assignments

- Homework:
  - 7-87, 7-90 in Cengel & Turner
  - Find rate of S_{gen} in 7-63 (Monday)
  - Find ΔS for 7-35 (no modification on Tuesday)
- Reading assignment
  - 8-5 to 8-7, 8-10, 8-11 in Cengel & Turner
  - ES 201 notes

Announcements

- Problem session this evening at 7 pm
- Short quiz next Monday on Week 7 materials

Road Map of Lecture 21

- Overview of what you have already learned
  - property changes
  - general substances versus models
  - constant versus variable specific heats (solution methods)
- Finish up example on adiabatic versus non-adiabatic turbine
- More examples
  - reinforce what was taught
  - introduce the limit of best performance
  - notion of isentropic efficiency
- Representation of isentropic and non-isentropic processes on *T-s* diagram

A Check List for You

- Property changes:
  - internal energy, enthalpy, entropy
  - general substances (State Principle) versus models
    - general substance: State Principle (exact differential)
    - definition of specific heats c_p, c_v
    - Gibbs equation (two different forms)
    - models: ideal gas, incompressible substance (resulting simplifications)
    - constant versus variable specific heats
  - different solution methods:
    - constant specific heats (analytical solutions)
    - variable specific heats:
      - direct integration (the hard way)
      - use property table (u, h, s^0, P_r, v_r) – the easier way
      - "average" specific heats (may require iterations if temperatures are unknown)
- Special case of isentropic process

In-Class Exercises

- Continue example on adiabatic versus non-adiabatic turbine
- Example on entropy generation

Isentropic Efficiency

- Central theme: the reversible, adiabatic (*i.e.* isentropic) process sets the limit of best performance of any system
- It also sets the reference for the definition of efficiency of compressors and turbines
- For compressors and pumps, work is done on the system:

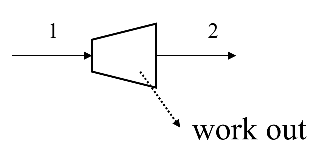
$$\eta_{comp} = \frac{\dot{W}_{isentropic}}{\dot{W}_{actual}}$$

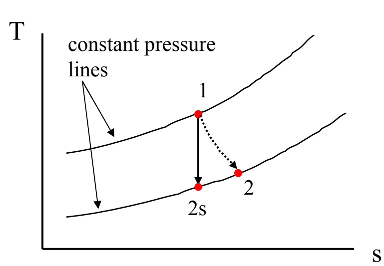
- For turbines, work is done by the system:

$$\eta_{turb} = \frac{\dot{W}_{actual}}{\dot{W}_{isentropic}}$$

Representation on *T*-*s* Diagram

- Turbine





- Compressor