ES 202
Fluid and Thermal Systems

Lecture 16:
Property Tables
(1/20/2003)

Road Map of Lecture 16

• Quiz on Lecture 15
• Phase determination in various regions
• Data interpolation
  – linear
  – bi-linear
• Compressed Liquid Approximation
• Practice with property tables
Phase Determination (Case 1)

- **Case 1**: Given \( P \) and \( T \)
  - Look up saturation table
  - Compare given \( P \) and \( T \) against saturation values in the table

- In pressure table,
  - Recall constant pressure line on \( T-v \) diagram
  - If \( T < T_{sat}(P) \),
    compressed liquid.
  - If \( T = T_{sat}(P) \),
    saturated liquid-vapor mixture.
  - If \( T > T_{sat}(P) \),
    superheated vapor.

Phase Determination (Case 1 Cont’d)

- **Case 1**: Given \( P \) and \( T \)
  - Look up saturation table
  - Compare given \( P \) and \( T \) against saturation values in the table

- In temperature table,
  - Recall constant temperature line on \( P-v \) diagram
  - If \( P > P_{sat}(T) \),
    compressed liquid.
  - If \( P = P_{sat}(T) \),
    saturated liquid-vapor mixture.
  - If \( P < P_{sat}(T) \),
    superheated vapor.
Phase Determination (Case 2)

• **Case 2**: Given $P$ (or $T$) and $v$ (or $u$, $h$, $s$)
  - Look up saturation table
  - Find saturated liquid and vapor values for $v$ (or $u$, $h$, $s$) at $P_{sat} = P$
  1) If $v < v_f(P_{sat})$, 
     compressed liquid.
  2) If $v = v_f(P_{sat})$, 
     saturated liquid.
  3) If $v_f(P_{sat}) < v < v_g(P_{sat})$, 
     saturated liquid-vapor mixture.
  4) If $v = v_g(P_{sat})$, 
     saturated vapor.
  5) If $v > v_g(P_{sat})$, 
     superheated vapor.

Flow Chart

- Determine phase of substance
  - Compressed liquid: Direct look up
  - Two-phase: Determine quality, Interpolate other properties
  - Superheated vapor: Direct look up
Data Interpolation

- The property tables only tabulate discrete values for pressure or temperature as the independent property.

- If you are interested in values which do not fall on the tabulated data points, interpolation within the “sandwich” interval will be necessary.

- Since the property tables report data at small intervals, linear interpolation should be adequate for most purposes.
  - Give example

- If both independent, intensive thermodynamic properties do not fall on the tabulated data points, bi-linear interpolation is necessary to completely specify the thermodynamic states.
  - Give example

Compressed Liquid Approximation

- If you find
  - the substance is a compressed (subcooled) liquid;
  - the compressed liquid table is unavailable or inadequate,

you may invoke the compressed liquid approximation:

\[
\begin{align*}
  u(T, P) &\approx u_f(T) \\
  v(T, P) &\approx v_f(T) \quad \text{(weak function of } T) \\
  s(T, P) &\approx s_f(T) \\
  h(T, P) &\approx u_f(T) + Pv_f(T) = h_f(T) + [P - P_{sat}(T)]v_f(T)
\end{align*}
\]