Notes To MEEG 344 students

How to compute the entropy \( s \) or entropy change \( \Delta s \) for a pure substance?
Prof. Lian-Ping Wang, University of Delaware

Gas / Vapor

a) **Superheated vapor tables**, (for \( \text{H}_2\text{O}, \text{R}-12, \text{R}-134a \) only)
directly from the tables

b) **Generalized departure chart, A-30**
\[
s(T, P) = s(T, P)_{\text{ideal gas}} - RZ_s (P_R, T_R)
\]
\[
s(T_2, P_2) - s(T_1, P_1) = \left[ s^o(T_2) - s^o(T_1) - R \ln \frac{P_2}{P_1} \right]_{\text{IG}} - R \left[ Z_s(P_{R2}, T_{R2}) - Z_s(P_{R1}, T_{R1}) \right]
\]

c) **Ideal gas tables**: A–17 through A–25, for Air, \( \text{N}_2, \text{O}_2, \text{CO}_2, \text{CO}, \text{H}_2, \text{H}_2\text{O}, \text{O}, \text{OH} \)
\[
s_2 - s_1 = s^o_2 - s^o_1 - R \ln \frac{P_2}{P_1}
\]

\( s^o \) depends on \( T \) only and can be found from these tables, it represents absolute entropy at the reference pressure of 1 atm (Page 774 of text).

d) Simply assuming **constant specific heats**, Table A–2a
\[
s_2 - s_1 = C_p \ln \frac{T_2}{T_1} - R \ln \frac{P_2}{P_1} = C_v \ln \frac{T_2}{T_1} + R \ln \frac{v_2}{v_1}
\]

Liquid-Vapor mixture: **Saturated mixture tables**, for \( \text{H}_2\text{O}, \text{R}-12, \text{R}-134a \) only
\[
s = s_f + x \times s_{fg}.
\]

Liquid / Solid:

a) by approximating compressed liquid as a saturated liquid at the same temperature, (use the saturation tables). For \( \text{H}_2\text{O}, \text{R}-134a \) only
\[
s(T, P) \approx s_f(T)
\]

b) assuming **constant specific heats** (A-3) and incompressible fluid with \( C_p = C_v = C \)
\[
s_2 - s_1 = C \ln \frac{T_2}{T_1}
\]