Typical Control Mass Problem Chart 2

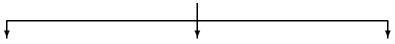
(Not complete material coverage)

State (1)

Normally 3 variables are needed to fully determine it.

2 known intensive variables

(May get away with T only in some approximations, eg, when using saturated values as an approximation for compressed liquids.)



Tables, eg B.1.1-B.1.4; pv or Tv diagrams;

 $v = v_f + x (v_g - v_f)$ and similar for u, h, and Ideal gas (applicable?) pv = RT (4 forms) Tables A5-A8 for u, h, s.

Make do with the formulae for *differences* in intensive variables listed below under "Process"?

Remaining intensive variables p, T, v, (x,)u, h, s.

Amount of material:

v = V/m u = U/m h = H/m s = S/m

Process

C1: Type of process $(V = C, p = C, p \text{ linear in } V, pV^n = C, T = C, {}_{1}Q_{2} = 0, \text{ reversible?})$

C2: Mass: $m_1 (+m_{\text{added}}) = m_2$

Energy: $E_2 - E_1 = {}_1Q_2 - {}_1W_2$ (E = U + KE? + PE?)

C3:
$$_{1}W_{2} = 0 \mid p(V_{2} - V_{1}) \mid \frac{p_{1} + p_{2}}{2}(V_{2} - V_{1}) \mid \frac{p_{2}V_{2} - p_{1}V_{1}}{1 - n} \mid p_{1}V_{1} \ln\left(\frac{V_{2}}{V_{1}}\right) \mid \text{other?}$$

 $_{1}Q_{2} = [0 \text{ and } S_{2} = S_{1}] \mid T(S_{2} - S_{1}) \mid \text{other?} \quad _{1}S_{2,\text{gen}} = \Delta S_{\text{net}} = S_{2} - S_{1} - \frac{_{1}Q_{2}}{T_{\text{surr}}}$

For ideal gases:

$$u_2 - u_1 = \int_1^2 C_v \, dT \approx C_{v_{\text{ave}}}(T_2 - T_1) \qquad h_2 - h_1 = \int_1^2 C_p \, dT \approx C_{p_{\text{ave}}}(T_2 - T_1)$$

$$s_2 - s_1 = s_T^0(T_2) - s_T^0(T_1) - R \ln\left(\frac{p_2}{p_1}\right) \approx C_{p_{\text{ave}}} \ln\left(\frac{T_2}{T_1}\right) - R \ln\left(\frac{p_2}{p_1}\right) = \dots$$

$$\text{Polytropic: } \frac{p_2}{p_1} = \left(\frac{v_1}{v_2}\right)^n = \left(\frac{T_2}{T_1}\right)^{\frac{n}{n-1}} \qquad \text{isothermal: } n = 1 \text{ ?}$$

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For solids and compressed liquids, by approximation, best at constant pressure:

$$_{1}Q_{2} = m \int_{1}^{2} C_{(p)} dT \approx m C_{(p)}_{\text{ave}} (T_{2} - T_{1}) \qquad s_{2} - s_{1} \approx C_{(p)}_{\text{ave}} \ln \left(\frac{T_{2}}{T_{1}}\right)$$

State 2

Same procedures as state (1)