Typical Control Mass Problem Chart

(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 and h.
- Ideal gas (applicable?) $pv = RT$ (4 forms) Tables A5-A8 for u, h.
- Make do with the formulae for *differences* in intensive variables listed below under “Process”?

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

Amount of material

$$v = V/m \qquad u = U/m \qquad h = H/m$$

Process

C1: Type of process (V constant, p constant, p linear in V, pV^n constant, T constant, ${}_1Q_2$ =0?)
Adds info about ① or ② ?

C2: Mass: $m_1\,(+m_{\text{added}}) = m_2$
Adds info about ① or ② ?
Energy: $E_2 - E_1 = {}_1Q_2 - {}_1W_2 \quad (E = U + KE? + PE?)$
Adds info about ① or ② ?

C3: ${}_1W_2 = 0$ | $p_1(V_2 - V_1)$ | $\dfrac{p_1 + p_2}{2}(V_2 - V_1)$ | $\dfrac{p_2V_2 - p_1V_1}{1-n}$ | $p_1V_1 \ln\left(\dfrac{V_2}{V_1}\right)$ | other?

For ideal gases:

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

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

$${}_1Q_2 = m\int_1^2 C_{(p)}\,\mathrm{d}T \approx mC_{(p)_{\text{ave}}}(T_2 - T_1)$$

State ②

Same procedures as state ①