Homework Notes

PV – PT – VT diagrams
Adiabatic

Total Energy Balance
The Total Energy Balance

Rate of change in Total Energy (\( dt \)) = Energy diff.: Streams in and out +
Work diff.: flow in and out + Heat into +
Work (changing system volume) in or out (-)+ Shaft (mechanical) Work in or out (-)

\[
\frac{d}{dt} \left( m \left( U + \frac{u^2}{2g_c} + \frac{gz}{g_c} \right) \right)
\]

Energy difference between Streams in and out =
\[
\sum_{\text{inlets-outlets}} \left( U + \frac{u^2}{2g_c} + \frac{gz}{g_c} \right) \dot{m}
\]

Work difference for flow in and out = \( \dot{W}_{\text{flow}} = (PV) \dot{m}^{\text{in}} - (PV) \dot{m}^{\text{out}} \)

Combining
\[
\left( U + \frac{u^2}{2g_c} + \frac{gz}{g_c} \right) \dot{m} + (PV) \dot{m} = \left( H + \frac{u^2}{2g_c} + \frac{gz}{g_c} \right) \dot{m}
\]

The result is:
\[
\frac{d}{dt} \left( m \left( U + \frac{u^2}{2g_c} + \frac{gz}{g_c} \right) \right) = \sum_{\text{inlets}} \left( H + \frac{u^2}{2g_c} + \frac{gz}{g_c} \right) \dot{m}^{\text{in}} - \sum_{\text{outlets}} \left( H + \frac{u^2}{2g_c} + \frac{gz}{g_c} \right) \dot{m}^{\text{out}} + \dot{Q} + \dot{W}_{\text{EC}} + \dot{W}_s
\]

Steady State: Neglecting Gravitational effects (minimal)

\[
0 = \sum_{\text{inlets}} \left( H + \frac{u^2}{2g_c} \right) \dot{m}^{\text{in}} - \sum_{\text{outlets}} \left( H + \frac{u^2}{2g_c} \right) \dot{m}^{\text{out}} + \dot{Q} + \dot{W}_{\text{EC}} + \dot{W}_s
\]

Neglecting velocity effects (except for nozzles and throttles):

\[
0 = \sum_{\text{inlets}} (H) \dot{m}^{\text{in}} - \sum_{\text{outlets}} (H) \dot{m}^{\text{out}} + \dot{Q} + \dot{W}_{\text{EC}} + \dot{W}_s
\]

If the system volume and mass are constant:
\[
\dot{m} \sum (H^{\text{out}} - H^{\text{in}}) = \dot{Q} + \dot{W}_s
\]

Per unit time:
\[
\dot{m} \sum (H^{\text{out}} - H^{\text{in}}) = Q + W_s
\]

Intensively:
\[
\Delta H = \frac{Q}{m} + \frac{W_s}{m}
\]
Home work Notes:

2.1 Use Appendices for Cp liquid and vapor and ΔH vap. (Tb), to find ΔH vap. (T).

2.4 Use Table from class

2.8 All from Steam tables

2.12 Start with the PV diagram. Note 2 moles of N₂.

Make Table: 1->step1->2->step2->3->step 3->1 and P, T, V, U, W, Q. Fill in the “0”s and given variables. Use ideal gas law to fill in other variables.