MACRO OPEN
E-BAZ ON INSIDE SYSTEM

\[ \Delta E_p + \Delta E_k + \Delta H = Q_{in} + W_{gs}, m \]

Q_{in}, water = \Delta H
no shafts

(see Felder + Rousseau)
\[ \Delta H = \sum_{\text{out}} m_i \hat{A}_i - \sum_{\text{in}} m_i \hat{A}_i \]

\[ = m \hat{A}_{\text{out}} - m \hat{A}_{\text{in}} \]

\[ \Delta H = m \left( \hat{A}_{\text{out}} - \hat{A}_{\text{in}} \right) \]

For a liquid, \( P \) constant, only \( T \) changing:

\[ \Delta \hat{A} = \int_{\text{Tin}}^{\text{Tout}} C_p(T) \,dT \]

\[ \approx \int_{\text{Tin}}^{\text{Tout}} (C_p, \text{mean}) \,dT \]
\[ \Delta H = \bar{c}_p \int_{T_{in}}^{T_{out}} dT \]

\[ \Delta H = \bar{c}_p (T_{out} - T_{in}) \]

\[ Q = m \Delta H = m \bar{c}_p (T_{out} - T_{in}) \]

\[ m \text{ is inside liquid water flow} \]
MACRO E-BAL in outside system:

\[ \Delta E_p + \Delta E_c + \Delta H = Q_{in} + \Delta H_{sk} \]

\[ Q_{in sk} = \Delta H \]

\[ = \sum_{out} m_i \dot{H} - \sum_{in} m_i \dot{H} \]

\[ = m' \dot{H}_{out} - m' \dot{H}_{in} \]

\[ = m' (\dot{H}_{out} - \dot{H}_{in}) \]

\[ = m' \Delta H_{out - in sk} \]
\[ \dot{m}_1 \left( H_{out} - H_{in} \right) = \dot{m}_1' \]

\[ \text{steam mass flow} \]

\[ \dot{m}_1' = ? \]

\[ \text{quality unknown} \]

\[ \dot{m}_1' \]

\[ \frac{\dot{m}_1'}{T'_2} = ? \]

\[ \text{in steam side} \]

\[ \text{out steam side} \]

\[ \Theta_i \]

\[ \frac{\dot{m}_1}{T'_1} = ? \]
\[ \hat{H}_1 = \int_{T_2}^{T_1} \hat{C}_p \, dT \]  
\[ \Delta H_2 = -\Delta H_{\text{Heat} \leftarrow \text{HE}} \]  
\[ \Delta H_3 = \int_{T_1}^{T_0} \hat{C}_p \, dT \]  
\[ \Delta H_{\text{out}} = \Delta H_1 + \Delta H_2 + \Delta H_3 \]  

\text{We can calculate } \Delta H \text{ along any convenient path!}
\[ Q_{in} = m'(-\Delta H_{vap}) \] (sensible heat terms neglected)

Macro EBAL Overall

\[ \Delta E_P + \Delta E_k + \Delta H = Q_{in} + W_{son} \]

Adiabatic

\[ Q_{in} = 0 \]
\[ \Delta H_{\text{overall system}} = 0 = Q_{\text{in, water side}} + Q_{\text{in, steam side}} \]

\[ \Rightarrow Q_{\text{in, water side}} = -Q_{\text{in, steam side}} \]

true?

It's a test of the assumption that the heat exchanger is adiabatic.