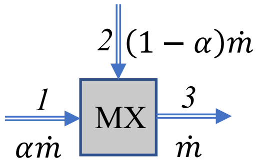
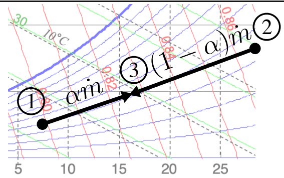
Process	Bloc diagram	Representation	Mathematical model

Adiabatic mixing

1. Mixing with given ratio

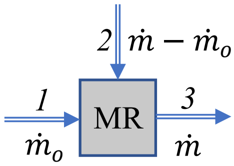


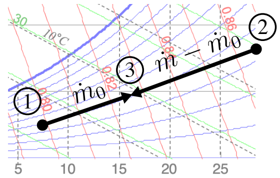


$$\begin{cases}\dot{m}c\theta_3 = \alpha\dot{m}c\theta_1 + (1-\alpha)\dot{m}c\theta_2 \\ \dot{m}lw_3 = \alpha\dot{m}lw_1 + (1-\alpha)\dot{m}lw_2\end{cases}$$

inputs: $\theta_1, \theta_2, w_1, w_2$
outputs: θ_3, w_3
parameters: $\dot{m}, \alpha$

2. Mixing with given mass flow rates



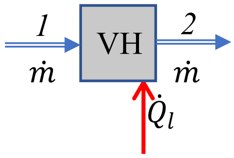


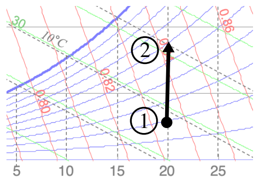
$$\begin{cases}\dot{m}c\theta_3 = \dot{m}_o c\theta_1 + (\dot{m}-\dot{m}_o)c\theta_2 \\ \dot{m}lw_3 = \dot{m}_o lw_1 + (\dot{m}-\dot{m}_o)lw_2\end{cases}$$

inputs: $\theta_1, \theta_2, w_1, w_2$
outputs: θ_3, w_3
parameters: $\dot{m}, \dot{m}_o$

Sensible and/or latent heat transfer

3. Vapor humidification

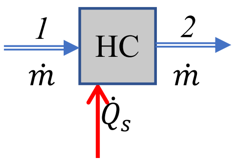


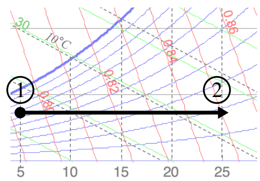


$$\begin{cases}\dot{m}c\theta_2 = \dot{m}c\theta_1 \\ \dot{m}lw_2 = \dot{m}lw_1 + \dot{Q}_l\end{cases}$$

inputs: $\theta_1, w_1, \dot{Q}_s, \dot{Q}_l$
outputs: θ_2, w_2
parameter: $\dot{m}$
Note: $\dot{Q}_l = \dot{m}_w l$

4. Heating or dry cooling

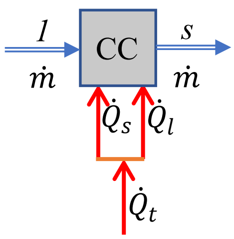


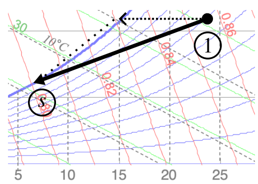


$$\begin{cases}\dot{m}c\theta_2 = \dot{m}c\theta_1 + \dot{Q}_s \\ \dot{m}lw_2 = \dot{m}lw_1\end{cases}$$

inputs: $\theta_1, w_1, \dot{Q}_s, \dot{Q}_l$
outputs: θ_2, w_2
parameter: $\dot{m}$

5. Cooling with dehumidification

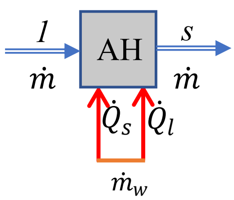


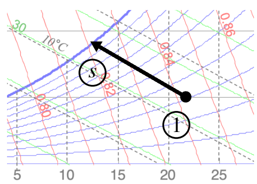


$$\begin{cases}\dot{m}c\theta_s = \dot{m}c\theta_1 + \dot{Q}_s \\ \dot{m}lw_s = \dot{m}lw_1 + \dot{Q}_l \\ w_s = f(\theta_s) \text{ linearized: } f'_{\theta_s^0}\theta_s - w_s = f'_{\theta_s^0}\theta_s^0 - w_s^0 \\ \dot{Q}_s + \dot{Q}_l = \dot{Q}_t\end{cases}$$

inputs: $\theta_1, w_1, \dot{Q}_t, \theta_s^0, w_s^0$
outputs: $\theta_s, w_s, \dot{Q}_s, \dot{Q}_l$
parameters: $\dot{m}, f'_{\theta_s^0}$
Notes 1) condensed water: $\dot{m}_w = \dot{Q}_l/l$
2) cooling coil total load: $\dot{Q}_t$

6. Adiabatic humidification or dehumidification

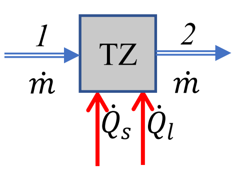


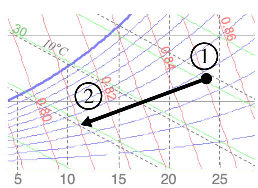


$$\begin{cases}c\theta_s + lw_s = c\theta_1 + lw_1 \\ w_s = f(\theta_s) \text{ linearized: } f'_{\theta_s^0}\theta_s - w_s = f'_{\theta_s^0}\theta_s^0 - w_s^0\end{cases}$$

inputs: $\theta_1, w_1, \theta_s^0, w_s^0$
outputs: θ_s, w_s
parameters: $\dot{m}, f'_{\theta_s^0}$
Notes 1) $Q_s = -Q_l$ are outputs
2) $\dot{Q}_l = \dot{m}_w l$
3) $\dot{m}_w = \dot{m}(w_s - w_1)$

7. Thermal zone

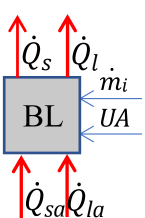




$$\begin{cases}\dot{m}c\theta_2 = \dot{m}c\theta_1 + \dot{Q}_s \\ \dot{m}lw_2 = \dot{m}lw_1 + \dot{Q}_l\end{cases}$$

inputs: $\theta_1, w_1, \dot{Q}_s, \dot{Q}_l$
outputs: θ_2, w_2
parameter: $\dot{m}$

8. Building



$$\begin{cases}\dot{Q}_s = (UA + \dot{m}_i c)(\theta_o - \theta_{TZ}) + \dot{Q}_{s,a} \\ \dot{Q}_l = \dot{m}_i l(w_o - w_{TZ}) + \dot{Q}_{l,a}\end{cases}$$

inputs: $UA, \dot{m}_i, \dot{Q}_{sa}, \dot{Q}_{la}$
$\theta_o, \theta_{TZ}, w_o, w_{TZ}$
outputs: $\dot{Q}_s, \dot{Q}_l$