

if $w_0 > w_{6,sp}$ \longrightarrow dehumidification \longrightarrow MX1, CC, MX2, HC, TZ, BL

if $w_0 < w_{6,sp}$ \longrightarrow humidification \longrightarrow MX1, HC,

if dehumidification

Mixing MX1

$$\begin{aligned} \dot{m} \cdot c \cdot \theta_1 &= \alpha \cdot \dot{m} \cdot c \cdot \theta_0 + (1-\alpha) \cdot \dot{m} \cdot c \cdot \theta_6 \\ \dot{m} \cdot l \cdot w_1 &= \alpha \cdot \dot{m} \cdot l \cdot w_0 + (1-\alpha) \cdot \dot{m} \cdot l \cdot w_6 \end{aligned}$$

Cooling with dehumidification CC

$$\begin{aligned} \alpha \cdot \dot{m} \cdot c \cdot \theta_2 &= \alpha \cdot \dot{m} \cdot c \cdot \theta_1 + Q_{s,cc} \\ \alpha \cdot \dot{m} \cdot l \cdot w_2 &= \alpha \cdot \dot{m} \cdot l \cdot w_1 + Q_{l,cc} \\ w_2 = f(\theta_s) &= f_{\theta_2}^l \cdot \theta_2 - w_2 = f_{\theta_2}^l \cdot \theta_{2,0} - w_{2,0} \\ Q_{t,cc} &= Q_{s,cc} + Q_{l,cc} \end{aligned}$$

Mixing after dehumidification MX2

$$\begin{aligned} \dot{m} \cdot c \cdot \theta_3 &= \beta \cdot \dot{m} \cdot \theta_2 + (1-\beta) \cdot \dot{m} \cdot \theta_1 \\ \dot{m} \cdot l \cdot w_3 &= \beta \cdot \dot{m} \cdot w_2 + (1-\beta) \cdot \dot{m} \cdot w_1 \end{aligned}$$

Heating coil HC

$$\begin{aligned} \dot{m} \cdot c \cdot \theta_4 &= \dot{m} \cdot c \cdot \theta_3 + Q_{s,hc} \\ \dot{m} \cdot l \cdot w_4 &= \dot{m} \cdot l \cdot w_3 \end{aligned}$$

Vapor humidification

$$\begin{aligned} \dot{m} \cdot c \cdot \theta_5 &= \dot{m} \cdot c \cdot \theta_4 \\ \dot{m} \cdot l \cdot w_5 &= \dot{m} \cdot l \cdot w_4 + Q_{l,vh} \\ &= 0 \end{aligned}$$

Thermal Zone

$$\begin{aligned} \dot{m} \cdot c \cdot \theta_6 &= \dot{m} \cdot c \cdot \theta_5 + Q_{s,B} \\ \dot{m} \cdot l \cdot w_6 &= \dot{m} \cdot l \cdot w_5 + Q_{l,B} \end{aligned}$$

Building

$$\begin{aligned} Q_{s,B} &= (U \cdot A + \dot{m} \cdot c) \cdot (\theta_0 - \theta_6) + Q_{s,a} \\ Q_{l,B} &= \dot{m} \cdot l \cdot (w_0 - w_6) + Q_{l,a} \end{aligned}$$

Indoor temperature controller

$$K\theta \cdot \theta_{6,sp} = K\theta \cdot \theta_6 + Q_{s,hc}$$

Indoor humidity controller

$$K_w \cdot w_{6,sp} = K_w \cdot w_6 + Q_{l,cc}$$

x = Vector of 18 unknowns:

$$\theta_1, w_1, \theta_2, w_2, \theta_3, w_3, \theta_4, w_4, \theta_5, w_5, \theta_6, w_6, \\ Q_{s,cc}, Q_{l,cc}, Q_{t,cc}, Q_{s,HC}, Q_{s,B}, Q_{l,B}$$

if humidification

Mixing MX1

$$\begin{aligned} \dot{m} \cdot c \cdot \theta_1 &= \alpha \cdot \dot{m} \cdot c \cdot \theta_0 + (1-\alpha) \cdot \dot{m} \cdot c \cdot \theta_6 \\ \dot{m} \cdot l \cdot w_1 &= \alpha \cdot \dot{m} \cdot l \cdot w_0 + (1-\alpha) \cdot \dot{m} \cdot l \cdot w_6 \end{aligned}$$

Cooling with dehumidification CC

$$\begin{aligned} \alpha \cdot \dot{m} \cdot c \cdot \theta_2 &= \alpha \cdot \dot{m} \cdot c \cdot \theta_1 + \cancel{Q_{s,cc}} = 0 \\ \alpha \cdot \dot{m} \cdot l \cdot w_2 &= \alpha \cdot \dot{m} \cdot l \cdot w_1 + \cancel{Q_{l,cc}} = 0 \end{aligned}$$

Mixing after dehumidification MX2

$$\begin{aligned} \dot{m} \cdot c \cdot \theta_3 &= \beta \cdot \dot{m} \cdot \theta_2 + (1-\beta) \cdot \dot{m} \cdot \theta_1 \\ \dot{m} \cdot l \cdot w_3 &= \beta \cdot \dot{m} \cdot w_2 + (1-\beta) \cdot \dot{m} \cdot w_1 \end{aligned}$$

Heating coil HC

$$\begin{aligned} \dot{m} \cdot c \cdot \theta_4 &= \dot{m} \cdot c \cdot \theta_3 + Q_{s,HC} \\ \dot{m} \cdot l \cdot w_4 &= \dot{m} \cdot l \cdot w_3 \end{aligned}$$

Vapor humidification

$$\begin{aligned} \dot{m} \cdot c \cdot \theta_5 &= \dot{m} \cdot c \cdot \theta_4 \\ \dot{m} \cdot l \cdot w_5 &= \dot{m} \cdot l \cdot w_4 + Q_{l,vh} \end{aligned}$$

Thermal zone

$$\begin{aligned} \dot{m} \cdot c \cdot \theta_6 &= \dot{m} \cdot c \cdot \theta_5 + Q_{s,B} \\ \dot{m} \cdot l \cdot w_6 &= \dot{m} \cdot l \cdot w_5 + Q_{l,B} \end{aligned}$$

Building

$$\begin{aligned} Q_{s,B} &= (U \cdot A + m_i \cdot c) \cdot (\theta_b - \theta_6) + Q_{s,a} \\ Q_{l,B} &= \dot{m}_i \cdot l \cdot (w_0 - w_6) + Q_{l,a} \end{aligned}$$

Indoor temperature controller

Indoor temperature controller

$$K\theta \cdot \theta_{6,sp} = K\theta \cdot \theta_6 + Q_{s,HC}$$

Indoor humidity controller

$$Kw \cdot w_{6,sp} = Kw \cdot w_6 + Q_{l,VH}$$

x = Vector of 16 unknowns:

$$\theta_1, w_1, \theta_2, w_2, \theta_3, w_3, \theta_4, w_4, \theta_5, w_5, \theta_6, w_6, Q_{s,HC}, Q_{l,VH}, Q_{s,B}, Q_{l,B}$$