1

$Tcal$

$Mean\_*$

$$Mean\_load/K = Trec + T_{load}$$

T_{load}

$Trec$

$$Mean\_atm/K = Trec + T_{emi}$$

T_B

$$Mean\_source/K = Trec + T_{emi} + B_s * e^{-\tau} * T_B$$

B_s

τ

$$T_B = Tcal * \frac{(Mean\_source - Mean\_atm)}{(Mean\_load - Mean\_atm)}$$

$$Tcal = (T_{load} - T_{emi}) \frac{e^{\tau}}{B_s}$$

$$Tsys = \frac{Tcal * Mean\_atm}{Mean\_load - Mean\_atm}$$

T_{emi}

$$T_{emi} = \frac{(T_{load} + Trec) * Mean\_atm}{Mean\_load} - Trec$$

$$T_{sky} = \frac{T_{emi} - (1. - F_{eff}) * T_{cab}}{F_{eff}}$$

$$F_{eff}$$

T_{cab}

$$T_{sky}$$

$$T_{sky} = \frac{T_{sky\_s} + T_{sky\_i} * Gain\_i}{(1. + Gain\_i)}$$

$$P_{amb}$$

T_{amb}

$$Tcal = \frac{(T_{load} * (1. + Gain\_i) - T_{emi\_s} - Gain\_i * T_{emi\_i})}{B_s * e^{-Tau\_s * Air\_mass}}$$

Tau_s

T_{rec}

$Gain\_i$

Air_mass

P_{amb}, T_{amb}

Humidity

Tau

$\mathrm{W}ater$

$$Trec = \frac{T_{load} * Mean\_atm - T_{emi} * Mean\_load}{Mean\_load - Mean\_atm}$$

$$Trec = \frac{T_{load} * Mean\_cold - T_{cold} * Mean\_load}{Mean\_load - Mean\_cold}$$

T_{atm_s}

$$T_{atm\_i}$$

Tau_i

$$T_{sky\_s} = T_{atm\_s} * (1. - e^{-Tau\_s * Air\_mass})$$

$$T_{sky\_i} = T_{atm\_i} * (1. - e^{-Tau\_i * Air\_mass})$$

$Tsys$

B_s

B_{eff}

T_A^*

$$\frac{1}{1 + Gain\_i * e^{(Tau\_s - Tau\_i) * Air\_mass}}$$

$e^{(Tau\_i - Tau\_s) * Air\_mass} / Gain\_i$

C_{eff}

$$Mean\_load/K = Trec + C_{eff} * T_{load} + (1 - C_{eff}) * T_{emi}$$

$$Tcal = C_{eff} * \frac{(T_{load} - T_{emi}) * (1. + Gain\_i)}{B_s * e^{-Tau\_s * Air\_mass}}$$

$$T_{emi} = \frac{(T_{load} + Trec) * Mean\_atm * C_{eff}}{Mean\_load - (1 - C_{eff}) * Mean\_atm} - Trec$$

$$Trec = \frac{C_{eff} * Mean\_atm * T_{load} - (Mean\_load - (1 - C_{eff}) * Mean\_atm) * T\_emi}{Mean\_load - Mean\_atm}$$

η

$$Mean\_load/K = \eta * (Trec + T_{load})$$

$$T_{emi} = \frac{\eta * (Trec + T_{load}) * Mean\_atm}{Mean\_load} - Trec$$

$$Trec = \frac{Mean\_cold * T_{load} - Mean\_load * T_{cold}}{Mean\_load - \eta * Mean\_cold}$$

$$T_B = e^{\tau} \frac{\eta}{B_s} (T_{load} + Trec) \frac{Mean\_sou - Mean\_atm}{Mean\_load}$$

$$T_{sky} = \tau * T_{atm}$$

$$T_{atm}$$

$$T_{emi} = F_{eff} * \tau * T_{atm} + (1 - F_{eff}) * T_{cab}$$

$$\tau = (T_{emi} - (1 - F_{eff}) * T_{cab}) / (F_{eff} * T_{atm})$$

$$Tcal = C_{eff} * (T_{load} - T_{emi})(1 + Gain\_i)/((1 - \tau) * B_s)$$

$$Tcal = C_{eff} \frac{(T_{load} - T_{emi}) * (1 + Gain\_i) * T_{atm} * F_{eff}}{B_s * (F_{eff} * (T_{atm} - T_{cab}) + T_{cab} - T_{emi})}$$

$$Tcal = C_{eff} \frac{F_{eff} * (1 + Gain\_i) * T_{atm}}{B_s * (1 - F_{eff} * \frac{T_{cab} - T_{atm}}{T_{cab} - T_{emi}})}$$

$$T_{cab} = 290K$$

$T_{atm} = 240K$

$T_{emi} = 50K$

$C_{eff} = 1$

$$Tcal = \frac{240 * (1 + Gain\_i) * F_{eff}}{B_s * (1 - 0.2 * F_{eff})}$$

$$T_{emi} = (1. - F_{eff}) * T_{cab} + F_{eff} * C^{te} * Water * Air\_mass$$

$$\frac{\partial Tcal}{\partial Trec} = \frac{\partial Tcal}{\partial T_{emi}} \frac{\partial T_{emi}}{\partial Trec} + \frac{\partial Tcal}{\partial Tau} \frac{\partial Tau}{\partial Trec}$$

$$\frac{\partial Tcal}{\partial T_{emi}} = \frac{Tcal}{T_{emi} - T_{load}}$$

$$\frac{\partial T_{emi}}{\partial Trec} = -1 + \frac{T_{emi} + Trec}{T_{load} + Trec}$$

$$\frac{\partial Tcal}{\partial T_{emi}} \frac{\partial T_{emi}}{\partial Trec} = \frac{Tcal}{T_{load} + Trec}$$

$$\frac{\partial Tcal}{\partial Tau} = Air\_mass * Tcal$$

$$\frac{\partial Tau}{\partial Trec} = \frac{\partial Tau}{\partial T_{emi}} \frac{\partial T_{emi}}{\partial Trec}$$

$$\frac{\partial Tau}{\partial Trec} = \frac{1}{Air\_mass * T_{atm} * F_{eff}} \frac{\partial T_{emi}}{\partial Trec}$$

$$\frac{\partial Tcal}{\partial Tau}\frac{\partial Tau}{\partial Trec} = \frac{Tcal}{T_{atm} * F_{eff}}\frac{T_{emi} - T_{load}}{T_{load} + Trec}$$

$$\frac{1}{Tcal}\frac{\partial Tcal}{\partial Trec} = \frac{T_{atm} * F_{eff} - T_{load} + T_{emi}}{F_{eff} * T_{atm} * (T_{load} + Trec)}$$

$$T_{load} = T_{cab}$$

$$\frac{1}{Tcal}\frac{\partial Tcal}{\partial Trec} = \frac{F_{eff}-1}{F_{eff}}\frac{1}{T_{load}+Trec}$$

3

10^{-4}

$$T_{cab}$$

$$\frac{1}{Tcal}\frac{\partial Tcal}{\partial T_{cab}} = \frac{(T_{atm} - T_{emi}}{(T_{cab} - T_{emi}) * (T_{cab} - T_{emi} - F_{eff} * (T_{cab} - T_{atm})}$$

3.6

10^{-3}

$$\frac{1}{Tcal}\frac{\partial Tcal}{\partial F_{eff}} = \frac{1}{F_{eff}} + \frac{1}{\frac{T_{cab}-T_{emi}}{T_{cab}-T_{atm}} - F_{eff}}$$

$$\frac{\partial Tcal}{\partial C_{eff}} = \frac{Tcal}{C_{eff}} - \frac{Tcal}{T_{load} - T_{emi}} \frac{\partial T_{emi}}{\partial C_{eff}}$$

$$\frac{\partial T_{emi}}{\partial C_{eff}} = \frac{(T_{emi} + Trec)^2}{T_{load} + Trec}$$

$$\frac{1}{Tcal}\frac{\partial Tcal}{\partial C_{eff}} = \frac{1}{C_{eff}} - \frac{(T_{emi} + Trec)^2}{C_{eff}^2 * (T_{load} + Trec) * (T_{load} - T_{emi})}$$

$$\frac{\partial Tcal}{\partial \eta} = \frac{Tcal}{\eta} + \frac{\partial Tau}{\partial \eta}\frac{\partial Tcal}{\partial Tau} + \frac{\partial Trec}{\partial \eta}\frac{\partial Tcal}{\partial Trec}$$

$$\frac{\partial Tau}{\partial \eta} = \frac{1}{T_{atm} * F_{eff}} \frac{\partial Temi}{\partial \eta}$$

$$\frac{\partial Temi}{\partial \eta} = -\frac{T_{emi} + Trec}{\eta^2} + \frac{\partial Trec}{\partial \eta} \frac{T_{emi} - T_{load}}{T_{load} + Trec}$$

$$\frac{1}{Tcal}\frac{\partial Tcal}{\partial \eta} = \frac{\eta * T_{atm} * Feff - T_{emi} - Trec}{\eta^2}$$

$$\frac{\partial Trec}{\partial \eta} = Trec \frac{Trec - T_{cold}}{T_{load} - \eta * T_{cold} + (1 - \eta) * Trec}$$

T_{cold}

II