



$$\begin{aligned}
C_{cav} \frac{dT_{cav}}{dt} &= \frac{T_{out} - T_{cav}}{R_{out,cav}} + \frac{T_{room} - T_{cav}}{R_{cav,room}} + \dot{Q}_{sol,cav} \\
C_{room} \frac{dT_{room}}{dt} &= \frac{T_{out} - T_{room}}{R_{out,room}} + \frac{T_{sur} - T_{room}}{R_{room,sur}} + \frac{T_{cav} - T_{room}}{R_{cav,room}} + \dot{Q}_{sol,room} + \dot{Q}_{int,room} \\
C_{sur} \frac{dT_{sur}}{dt} &= \frac{T_{room} - T_{sur}}{R_{room,sur}} + \frac{T_{so} - T_{sur}}{R_{sur,so}} + \dot{Q}_{sol,sur} + \dot{Q}_{int,sur} \\
C_{so} \frac{dT_{so}}{dt} &= \frac{T_{sur} - T_{so}}{R_{sur,so}} + \frac{T_{si} - T_{so}}{R_{si,so}} \\
C_{si} \frac{dT_{si}}{dt} &= \frac{T_{so} - T_{si}}{R_{so,si}} \\
x^T &= [T_{cav}, T_{room}, T_{sur}, T_{so}, T_{si}] \\
u^T &= [T_{out}, \dot{Q}_{sol,cav}, \dot{Q}_{sol,room}, \dot{Q}_{int,room}, \dot{Q}_{sol,sur}, \dot{Q}_{int,sur}, \frac{dT_{so}}{dt}] \\
y &= \dot{Q}_{rslab} = \frac{T_{sur} - T_{so}}{R_{sur,so}} + \frac{T_{si} - T_{so}}{R_{si,so}} - C_{so} \frac{dT_{so}}{dt}
\end{aligned}$$

$$\begin{bmatrix} \frac{dT_{cav}}{dt} \\ \frac{dT_{room}}{dt} \\ \frac{dT_{sur}}{dt} \\ \frac{dT_{so}}{dt} \\ \frac{dT_{si}}{dt} \end{bmatrix} = \begin{bmatrix} \left(\frac{-1}{R_{out,cav}C_{cav}} + \frac{-1}{R_{cav,room}C_{cav}} \right), \frac{1}{R_{cav,room}C_{cav}}, 0, 0, 0 \\ \frac{1}{R_{cav,room}C_{room}}, \left(\frac{-1}{R_{out,room}C_{room}} + \frac{-1}{R_{room,sur}C_{room}} + \frac{-1}{R_{cav,room}C_{room}} \right), \frac{1}{R_{room,sur}C_{room}}, 0, 0 \\ 0, \frac{1}{R_{room,sur}C_{sur}}, \left(\frac{-1}{R_{room,sur}C_{sur}} + \frac{-1}{R_{sur,so}C_{sur}} \right), \frac{1}{R_{sur,so}C_{sur}}, 0 \\ 0, 0, \frac{1}{R_{sur,so}C_{so}}, \left(\frac{-1}{R_{sur,so}C_{so}} + \frac{-1}{R_{si,so}C_{so}} \right), \frac{1}{R_{si,so}C_{so}} \\ 0, 0, 0, \frac{1}{R_{so,si}C_{si}}, \frac{-1}{R_{so,si}C_{si}} \end{bmatrix} \begin{bmatrix} T_{cav} \\ T_{room} \\ T_{sur} \\ T_{so} \\ T_{si} \end{bmatrix} + \begin{bmatrix} \frac{1}{R_{out,cav}C_{cav}}, 1, 0, 0, 0, 0, 0 \\ \frac{1}{R_{out,room}C_{room}}, 0, 1, 1, 0, 0, 0 \\ 0, 0, 0, 0, 1, 1, 0 \\ 0, 0, 0, 0, 0, 0, 0 \\ 0, 0, 0, 0, 0, 0, 0 \end{bmatrix} \begin{bmatrix} T_{out} \\ \dot{Q}_{sol,c} \\ \dot{Q}_{sol,ro} \\ \dot{Q}_{int,ro} \\ \dot{Q}_{sol,s} \\ \dot{Q}_{int,s} \\ \frac{dT_{so}}{dt} \end{bmatrix}$$

$$y = \dot{Q}_{rslab} = \begin{bmatrix} 0 & 0 & \frac{1}{R_{sur,so}} & (\frac{-1}{R_{sur,so}} + \frac{-1}{R_{si,so}}) & \frac{1}{R_{si,so}} \end{bmatrix} \begin{bmatrix} T_{cav} \\ T_{room} \\ T_{sur} \\ T_{so} \\ T_{si} \end{bmatrix} + \begin{bmatrix} 0 & 0 & 0 & 0 & 0 & 0 & -C_{so} \end{bmatrix} \begin{bmatrix} T_{out} \\ \dot{Q}_{sol,cav} \\ \dot{Q}_{sol,room} \\ \dot{Q}_{int,room} \\ \dot{Q}_{sol,sur} \\ \dot{Q}_{int,sur} \\ \frac{dT_{so}}{dt} \end{bmatrix}$$

$$A = \begin{bmatrix} (\frac{-1}{R_{out,cav}C_{cav}} + \frac{-1}{R_{cav,room}C_{cav}}) & \frac{1}{R_{cav,room}C_{cav}} & 0 & 0 & 0 \\ \frac{1}{R_{cav,room}C_{room}} & (\frac{-1}{R_{out,room}C_{room}} + \frac{-1}{R_{room,sur}C_{room}} + \frac{-1}{R_{cav,room}C_{room}}) & \frac{1}{R_{room,sur}C_{room}} & 0 & 0 \\ 0 & \frac{1}{R_{room,sur}C_{sur}} & (\frac{-1}{R_{room,sur}C_{sur}} + \frac{-1}{R_{sur,so}C_{sur}}) & \frac{1}{R_{sur,so}C_{sur}} & 0 \\ 0 & 0 & \frac{1}{R_{sur,so}C_{so}} & (\frac{-1}{R_{sur,so}C_{so}} + \frac{-1}{R_{si,so}C_{so}}) & \frac{1}{R_{si,so}C_{so}} \\ 0 & 0 & 0 & \frac{1}{R_{so,si}C_{si}} & \frac{-1}{R_{so,si}C_{si}} \end{bmatrix}$$

$$B = \begin{bmatrix} \frac{1}{R_{out,cav}C_{cav}} & 1 & 0 & 0 & 0 & 0 & 0 \\ \frac{1}{R_{out,room}C_{room}} & 0 & 1 & 1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 1 & 1 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 \end{bmatrix}$$

$$c = \begin{bmatrix} 0 & 0 & \frac{1}{R_{sur,so}} & (\frac{-1}{R_{sur,so}} + \frac{-1}{R_{si,so}}) & \frac{1}{R_{si,so}} \end{bmatrix}$$

$$d = \begin{bmatrix} 0 & 0 & 0 & 0 & 0 & 0 & -C_{so} \end{bmatrix}$$

paras:

1. r out cav
2. r cav room
3. r out room
4. r room sur
5. r sur so
6. r si so
7. c cav
8. c room
9. c sur
10. c so
11. c si