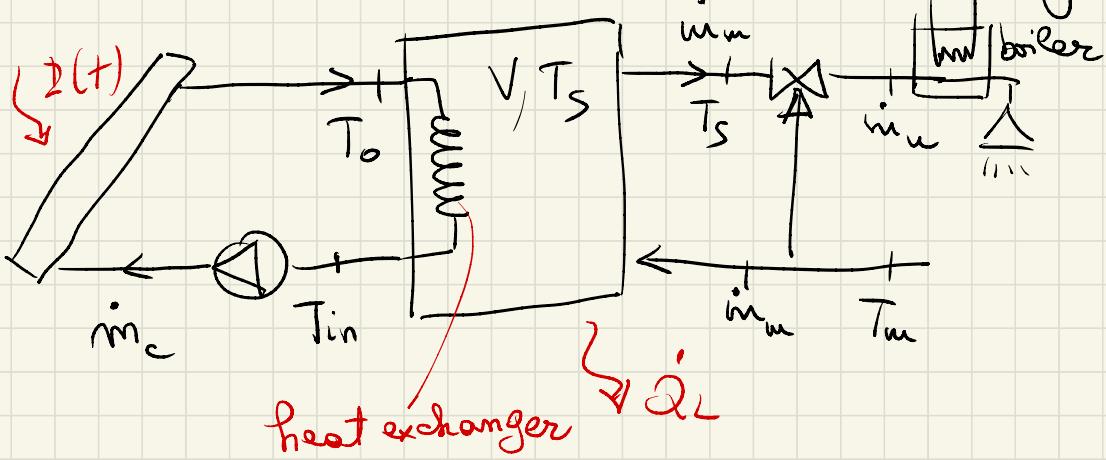


Assignment 2 - Solar thermal + storage



Collector model

$$\dot{m}_c c (T_0 - T_{in}) = \eta(T_{in}) I(t) A$$

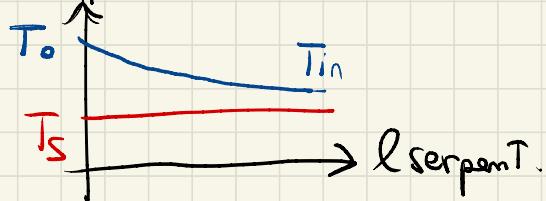
$$\eta(T_{in}) = \eta_0 - U \cdot \frac{T_{in} - T_a}{I}$$

Flow rate choice

$$\dot{m}_c = \begin{cases} \dot{m}_c = \text{const}, & \text{if } I > 0 \text{ & } \eta > 0 \\ 0, & \text{otherwise} \end{cases}$$

Heat exchanger model

T profile



$$\begin{aligned} \dot{Q}_{exch} &= \dot{m}_c c (T_0 - T_{in}) = \\ &= \epsilon \dot{m}_c (T_0 - T_S) \end{aligned}$$

↓
effectiveness → given

$$\Rightarrow T_{in} = T_0 - \varepsilon(T_0 - T_s)$$

DYNAMICS

Thermal energy balance

$$\left\{ \begin{array}{l} 1) \dot{m}_c c (T_0 - T_{in}) = \eta(T_{in}) I(+) A \\ 2) T_{in} = T_0 - \varepsilon (T_0 - T_s) \\ 3) \dot{m}_c c (T_0 - T_{in}) - \dot{Q}_L - h A (T_s - T_{room}) = \\ = M_s c \dot{T}_s \end{array} \right.$$

Algebraic.
 Find
 $T_{in}(T_s), T_0(T_s)$

↓
 solve for T_s

with

$$4) \dot{Q}_L = \begin{cases} \dot{m}_u c (T_u - T_w), & \text{if } T_u \leq T_s \\ \dot{m}_u c (T_s - T_w), & \text{if } T_u > T_s \end{cases}$$

$$5) \dot{Q}_{\text{borden}} = \begin{cases} 0, & T_u \leq T_s \\ \dot{m}_u c (T_u - T_s), & T_u > T_s \end{cases}$$

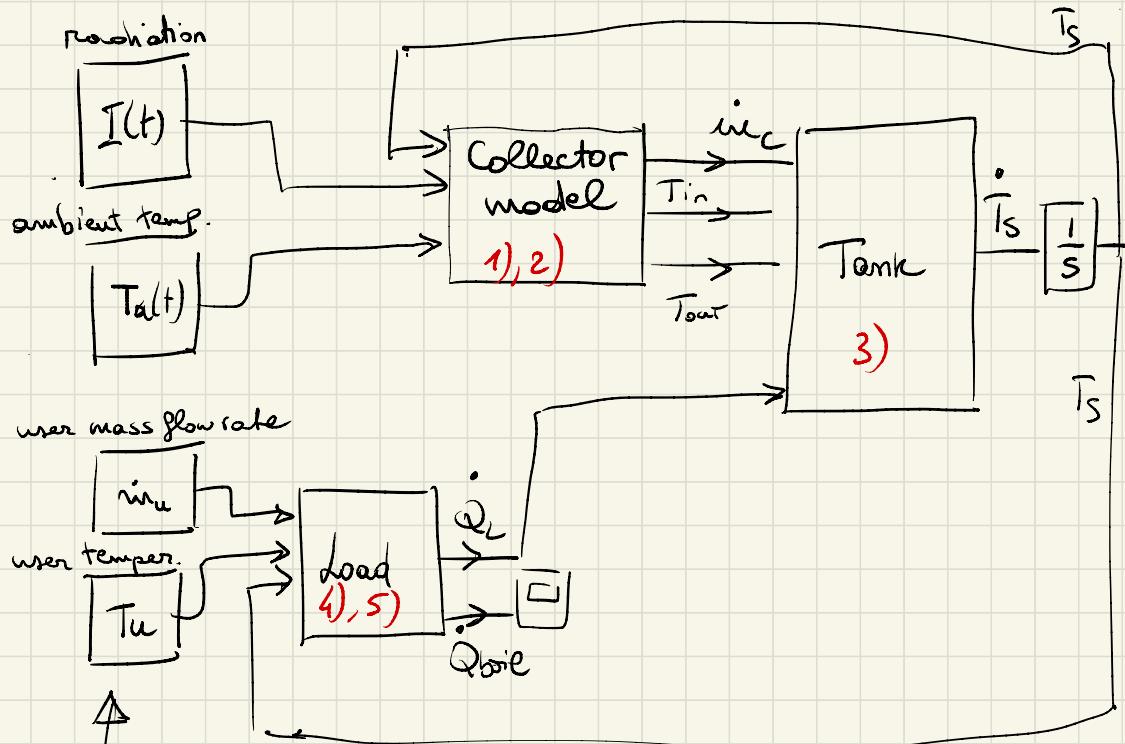
Energy extracted from panel

$$\mathcal{E}_c = \int \eta(T_{in}) I dt$$

Energy provided by the boiler

$$E_b = \int Q_{\text{boiler}} dt$$

Possible structure of Simulink block diagram



blocks (e.g. repeating sequence interpolated) that output the radiation, ambient temperature, user consumed flow rate and requested temperature as a function of time