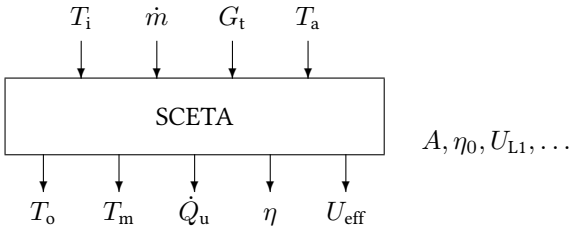
Block SCETA

The SCETA block simulates a solar collector on the basis of the collector equation.





Name	SCETA
Function	st0008
Inputs	4
Outputs	5
Parameters	7 . . . [8]
Strings	0 . . . [1]
Group	S

Inputs

1 Inlet temperature T_i / °C
2 Mass flow rate $\dot{m}$ / kg s^{-1} (or mean fluid temperature T_m / °C: mode 1)
3 Global radiation on the generator plane G_t / W m^{-2}
4 Ambient temperature T_a / °C

Outputs

1 Outlet temperature T_o / °C
2 Mean fluid temperature T_m / °C
3 Useful heat $\dot{Q}_\mathrm{u}$ / W
4 Efficiency η (can be greater than one due to convective gains)
5 Effective heat-loss coefficient U_eff / W m^{-2} K^{-1}

Parameters

1 Absorber area A / m^2
2 Maximum efficiency $\eta_0 = (\tau\alpha)F'$
3 Efficiency parameter U_{L1} / W m^{-2} K^{-1}
4 Efficiency parameter U_{L2} / W m^{-2} K^{-2}
5 Specific heat of collector fluid c_p / J kg^{-1} K^1
6 Number of collectors in series N_s

7 Number of collectors in parallel N_p
8 Temperature mode
0 INS(2) = Mass flow rate (default)
1 INS(2) = Mean fluid temperature

Strings

1 Product ID

Description

The collector equation is given by

$$\eta = \eta_0 - U_{L1}\frac{T_\mathrm{m} - T_\mathrm{a}}{G} - U_{L2}\frac{(T_\mathrm{m} - T_\mathrm{a})^2}{G}$$

with the mean fluid temperature T_m, G being the global radiation in the collector plane and the three fit parameters η_0, U_L1, and U_L2. The mean fluid temperature T_m may be approximated by the mean value of the collector inlet temperature T_i and the collector outlet temperature T_o

$$T_\mathrm{m} = \frac{T_\mathrm{i} + T_\mathrm{o}}{2}$$

The useful power is then given by

$$\dot{Q}_\mathrm{u} = \eta G A = \dot{m} c_\mathrm{p} (T_\mathrm{o} - T_\mathrm{i})$$

where A represents the absorber area and $\dot{m}$ the mass flow rate.

In case $U_{L2} = 0$ the outlet temperature is found to be

$$T_\mathrm{o} = \frac{\eta_0 G + T_\mathrm{i}\dot{m}c_\mathrm{p}/A - U_\mathrm{L1}T_\mathrm{i}/2 + U_\mathrm{L1}T_\mathrm{a}}{\dot{m}c_\mathrm{p}/A + U_\mathrm{L1}/2}$$

T_o cannot exceed the stagnation temperature

$$T_\mathrm{max} = \frac{1}{U_\mathrm{L1}}\left(\eta_0 G - \frac{U_\mathrm{L1}T_\mathrm{i}}{2} + U_\mathrm{L1}T_\mathrm{a}\right)$$

The case where $U_{L2} \neq 0$ leads to a slightly more complex quadratic equation with the solutions

$$T_{\mathrm{o}1/2} = -\frac{p}{2} \pm \sqrt{(\frac{p}{2})^2 - q}$$

with the coefficients

$$p = \frac{2U_\mathrm{L1}}{U_\mathrm{L2}} + 2T_\mathrm{i} - 4T_\mathrm{a} + \frac{2\dot{m}c_\mathrm{p}}{AU_\mathrm{L2}}$$

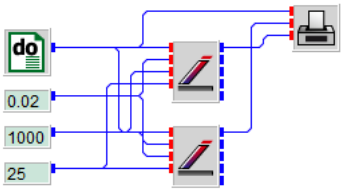
and

$$q = \left(2\frac{U_{L1}}{U_{L2}} - 4T_a + T_i - \frac{4\dot{m}c_p}{AU_{L2}}\right)T_i - 4\left(\frac{G\eta_0}{U_{L2}} + \frac{U_{L1}T_a}{U_{L2}} + {T_a}^2\right)$$

The effective heat-loss coefficient U_{eff} is calculated from

$$U_{eff} = U_{L1} + U_{L2}(T_m - T_a)$$

sceta.vseit



Two SCETA blocks are used to compare the influence of serial and parallel connections of solar collectors. The upper SCETA block simulates eight collectors connected in series, the lower one simulates eight collectors in parallel. Both use a specific heat of the collector fluid of 3900 J kg^{-1} K^{-1} (water) and the temperature mode "IN(2) = Mass flow rate".

The mass flow is set to 0.02 kg/s, the irradiance to 1000 W/m^2, and the ambient temperature to 25 °C by three CONST blocks.

A DO block varies the collector inlet temperature from 25 to 100 °C in steps of 1 °C.

The PLOT block displays the two different collector outlet temperatures.

