Parabolic Trough Collector

A parabolic trough collector is composed of a curved mirror that receive sun irradiation and that concentrate it on a heat collection element. A heat transfer fluid flows through that heat collection element to send back the heat collected to a thermodynamic cycle or to any other process requiring heat. This model computes the thermal power absorbed by the PT collector and the heat transfer fluid conditions at its output, considering the heat losses considered from a semi-empirical correlation.

The parabolic trough collector is discretised into n_{disc} numbers of discretisation's on the length of the heat collection element, which can be considered as equal to the length of the whole parabolic trough collector. For each discretisation, the local heat losses are calculated thanks to a correlation with 9 parameters proposed by Dickes et al. [1]. A schematic representation of the modelled device is given on Figure 1.

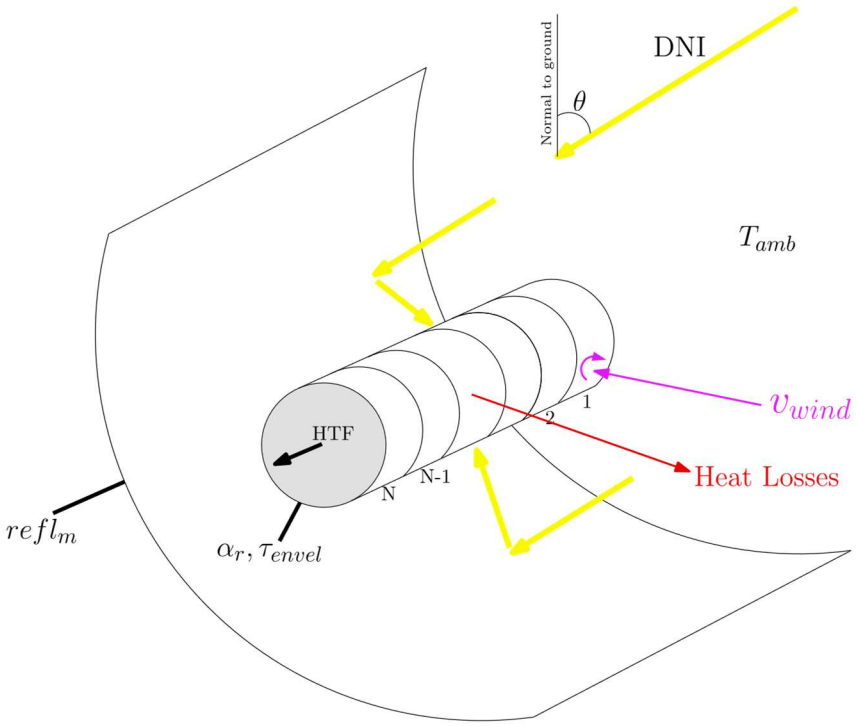

Figure 1: Schematic representation of the Parabolic Trough Collector.

The modelling is proceeded along with the following steps:

- For each discretised element, the sun thermal power received by the heat collection element is set as the effective irradiance arriving to it times the optical efficiency of the device, computed according to the following equation:

$$\dot{Q}_{sun,i} = DNI.cos(\Theta).\eta_{opt}.W_{PTC}.\Delta x$$

With the optical efficiency being:

$$\eta_{opt} = \tau_{envel}.\alpha_r.refl_m.\eta_{other}$$

With:

DNI: Direct Normal Irradiation. $[W/m^2]$

Θ: Sun incidence angle. $[rad]$

W_{PTC}: Width/Aperture of the Parabolic Trough Collector. $[m]$

Δx: Discretised length. $[m]$

τ_{envel}: transmittance of the heat collection element envelop. $[-]$

α_r: Receiver absorptivity. $[-]$

$refl_m$: Mirror reflectivity. $[-]$

η_{other}: Efficiency of the eventual other phenomenon's. $[-]$

- Then, the linear heat losses of each discretisation are computed according to the correlation of Dickes et al [1], and then multiplied by the discretised length to get the local heat losses.
- Finally, the absorbed thermal power is computed at each discretisation as the thermal power received by the heat collection element minus the heat losses.
- The outputs of this model are the total thermal power absorbed by the PT collector and the heat transfer fluid conditions at its output (from specific enthalpy).

[1] R. Dickes, V. Lemort, and S. Quoilin, 'Semi-empirical correlation to model heat losses along solar parabolic trough collectors', Available: https://orbi.uliege.be/handle/2268/182680