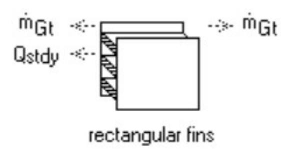
Sage Model Notes

HeatExchanger-ExternalPath.scfn

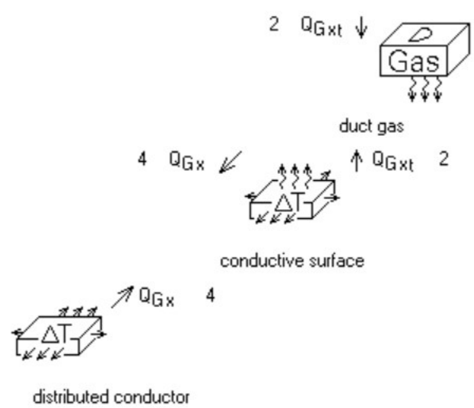
D. Gedeon
25 November 2024

A heat exchanger model that anchors the temperature by thermal connection to an ultimate heat source or sink located in an external component, rather than to an isothermal surface or line heat source located inside the heat exchanger component, as in the HeatExchangers-SimpleIsothermal.scfn samples. In this model the connection to the external source or sink occurs through a distributed conductor component, which might correspond to a physical solid conduction path, such as the canister wall in a porous-matrix heat exchanger. Or it might just represent a fictitious component introduced solely for convenience — a thermal *busbar* if you will. Whatever it is, it can simplify energy-flow accounting by forcing all heat flows to terminate in a point temperature source at the root level where it is possible to optimize or map that temperature through a single variable.

The idea is illustrated here as a modification to the Rectangular Fins example in the HeatExchangers-SimpleIsothermal.scfn model. It starts with the rectangular fins component on the *Heat Exchangers* page of the root-model component palette:



The $\dot{m}_{Gt}$ connector arrows originate from the duct gas components inside and the Q_{stdy} connector arrow originates from the distributed conductor:

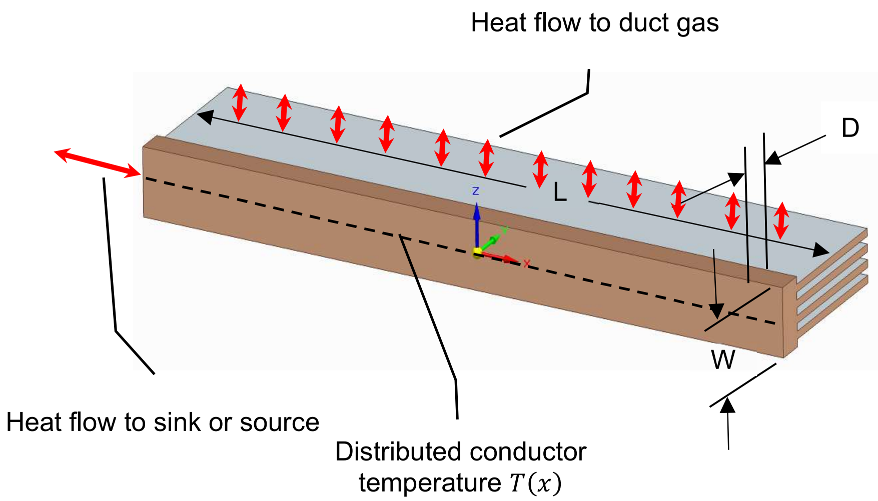


The duct gas and conductive surface components are the same as in the HeatExchangers-SimpleIsothermal.scfn sample model and will not be discussed further here.

The distributed conductor is essentially a rectangular solid that can transfer heat through its sides and ends, depending on how it is connected. Input variable W should be set to the perimeter in contact with the heat exchanger — the heat-exchanger circumference in a cylindrical arrangement. See sample model HeatExchanger-ThermalConductors for specific examples. Input variable `D` is the busbar thickness — the radial depth in a cylindrical arrangement. Input variable `Solid` is the conducitve material. Copper gives the least temperature drop. In the present example *distributes* from the x-direction along the length to the y-direction into the fins.

Sage models the heat flow in the distributed conductor using a lumped-parameter approximation, which is the best the one-dimension Sage solution grid can do. See the Distributed Conductor section of the Sage User's Guide (Help | PDF Manual) for details.

In the illustration below the distributed-conductor temperature $\mathrm{T}(\mathrm{x})$ anchors the fin bases. Inputs `D` and `W` represents the distributed-conductor cross-section dimensions and L comes from the rectangular-fins `Length`.



Sage solves the distributed-conductor temperature $T(x)$ based the thermal conductivity and heat flow equations within the distributed conductor and the thermal boundary conditions provided by the temperature of the source or sink attached to the left endpoint and the temperature of the gas attached to the fin faces.