

Documentation for the pyroll-thermal-2d Plugin

Max Weiner

January 13, 2023

1 Model Description

$$0 = \dot{q}_1 - \dot{q}_2 - \dot{q}_3 + \dot{q}_4 \quad (1)$$

$$\dot{m} = \varrho \pi \frac{\Delta x}{\Delta t} \left(\frac{\Delta r}{2} \right)^2 \quad (2)$$

$$\dot{q}_1 = c_p \dot{m} T_i^n \quad (3)$$

$$\dot{q}_2 = c_p \dot{m} T_i^{n+1} \quad (4)$$

$$\dot{q}_3 = -\lambda \frac{T_{i+1}^n - T_i^n}{\Delta r} \times 2\pi \Delta x \left(r_i + \frac{\Delta r}{2} \right) \quad (5)$$

$$\dot{q}_4 = -\lambda \frac{T_i^n - T_{i-1}^n}{\Delta r} \times 2\pi \Delta x \left(r_i - \frac{\Delta r}{2} \right) \quad (6)$$

$$\dot{q}_3 = 2\pi r \Delta x \left[-\alpha (T_\infty - T_S) - \epsilon_0 \epsilon_r (T_\infty^4 - T_S^4) \right] \quad (7)$$

$$2\lambda \frac{T_S - T_I^n}{\Delta r} = \alpha (T_\infty - T_S) + \epsilon_0 \epsilon_r (T_\infty^4 - T_S^4) \quad (8)$$

for core layer $\dot{q}_4 = 0$

$$\Delta T_0 = \frac{\pi \lambda \Delta x \Delta t}{\varrho c_p V} (T_1^n - T_0^n) \quad (9)$$

$$\Delta T_i = \frac{2\pi \lambda \Delta x \Delta t}{\varrho c_p V \Delta r} \left[(T_{i+1}^n - T_i^n) \left(r_i + \frac{\Delta r}{2} \right) - (T_i^n - T_{i-1}^n) \left(r_i - \frac{\Delta r}{2} \right) \right] \quad (10)$$

$$\Delta T_I = \frac{2\pi \lambda \Delta x \Delta t}{\varrho c_p V} \left[\left[\alpha (T_\infty - T_S) + \epsilon_0 \epsilon_r (T_\infty^4 - T_S^4) \right] \left(r_I + \frac{\Delta r}{2} \right) - \lambda \frac{T_I^n - T_{I-1}^n}{\Delta r} \left(r_I - \frac{\Delta r}{2} \right) \right] \quad (11)$$

2 Plugin Usage

Symbols

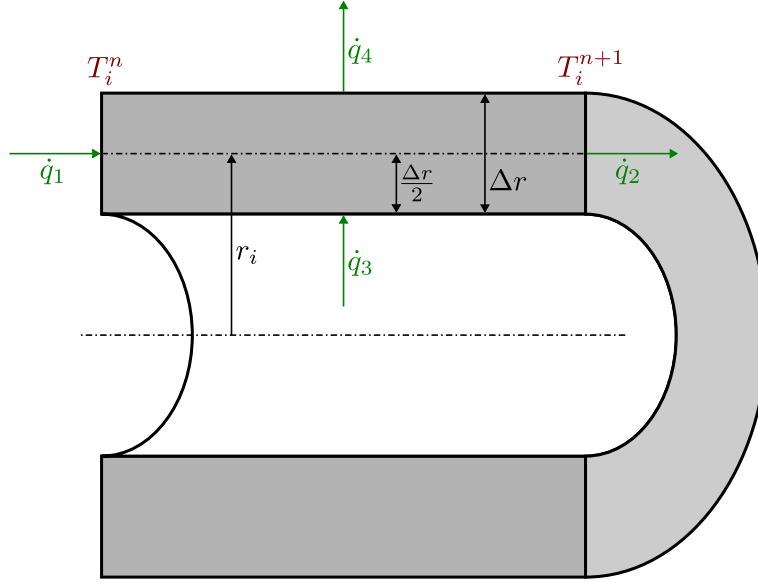


Figure 1: Heat Flows on a Disk Element Ring

Symbol	Description
α	Heat transfer coefficient
c_p	Thermal Capacity
\dot{m}	Mass flow in x-direction
\dot{q}	Heat flow
\dot{q}_S	Heat source (generation)
ϵ_0	Radiation coefficient of black radiator
ϵ_r	Relative radiation coefficient
i	Index of raster in radius
I	Maximum index of raster in radius
λ	Thermal conductivity
n	Index of raster in x
N	Maximum index of raster in x
r	Radius coordinate in polar systems
Δr	Discretization width in radius
t	Time
Δt	Discretization width in time

Continued on next page

Table 0: (Continued)

T	Absolute temperature
ΔT	Increment of temperature
T_{∞}	Environemnt temperature
T_S	Absolute surface temperature
V	Volume of the disk element rep. layer
ϱ	Density
x	X Coordinate
Δx	Discretization width in x