TEI Larissa
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bark 0.5.2

1d Multi-layer heat transfer simulation software

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Mathematical Model

2.1 Energy balance

$$\frac{\partial}{\partial t}\left(\rho C_p T\right) = \frac{\partial}{\partial x}\left(k\frac{\partial T}{\partial x}\right) + S. \tag{2.1}$$

2.2 Boundary conditions

2.2.1 Solar irradiation

2.2.2 Radiation in transparent materials

Chapter 3

Input file

3.1 Magnitudes

Magnitude	**Default unit**	**Alternative units**
Dimensionless	$-$	
Length	m	cm, mm
Time	s	$min, hour, day$
Angle	deg	rad
Temperature	K	$degC$
Thermal conductivity	W/mK	
Heat capacity	J/kgK	
Density	$kg/m3$	
Velocity	m/s	
Heat transfer coefficient	$W/m2K$	
Heat flux	$W/m2$	
Date	$month$	

3.2 Parameter types

Type	Syntax	Description
group	<tag> <child_tag1>. . . </child_tag1> <child_tag2>. . . </child_tag2> . . . </tag>	A group of parameters.
constant	<tag> <constant> 1.0 </constant> </tag>	A magnitude which remains constant throught the simulation. Only one numerical value is defined.
variable	<tag> <variable> 0.0 1.0 1.0 4.0 . . . </variable> </tag>	A magnitude which varies a function of another magnitude. An array with two columns and unlimited rows is defined.
function	<tag> <function> <function1> </function1> </function> </tag>	A magnitude which varies a function of another magnitude. A internal function is selected and the necessary numerical parameters are defined.
reference	<tag reference="target_tag"/>	A reference to another parameter defined by name.
keyword	<tag> <keyword> keyword1 </keyword> </tag>	A parameter defined with keywords.

Chapter 4

case

Simulation Case

Tag	Type	Parameter	Value	Description
simulation	group	**Section**	4.1	simulation parameters
		Usage	obligatory	
		Occurencies	1	
setup	group	**Section**	4.2	setup parameters
		Usage	obligatory	
		Occurencies	1	
output	group	**Section**	4.3	output parameters
		Usage	obligatory	
		Occurencies	1	

4.1 simulation

simulation parameters

Tag	Type	Parameter	Value	Description
start_time	constant	**Magnitude**	Time	start time
		Usage	obligatory	
		Occurencies	1	
end_time	constant	**Magnitude**	Time	end time
		Usage	obligatory	
		Occurencies	1	
time_step	constant	**Magnitude**	Time	time step
		Usage	obligatory	
		Occurencies	1	
space_step	constant	**Magnitude**	Length	space step
		Usage	obligatory	
		Occurencies	1	
initial _temperature	constant	**Magnitude**	Temperature	initial temperature
		Usage	obligatory	
		Occurencies	1	

4.2 setup

setup parameters

Tag	Type	Parameter	Value	Description
materials	group	**Section**	4.2.1	Materials list
		Usage	obligatory	
		Occurencies	1	
layers	group	**Section**	4.2.2	layers
		Usage	obligatory	
		Occurencies	1	
boundaries	group	**Section**	4.2.3	boundaries
		Usage	obligatory	
		Occurencies	1	
geometry	group	**Section**	4.2.4	wall geometry
		Usage	obligatory	
		Occurencies	1	
position	group	**Section**	4.2.5	position
		Usage	optional	
		Occurencies	1	

4.2.1 materials

Materials list

Tag	Type	Parameter	Value	Description
material	group	**Section**	4.2.1	material
		Usage	obligatory	
		Occurencies	-1	

material material

Tag	Type	Parameter	Value	Description
conductivity	constant	**Magnitude**	Thermal conductivity	thermal conductivity
		Usage	obligatory	
		Occurencies	1	
heat _capacity	constant	**Magnitude**	Heat capacity	heat capacity
		Usage	obligatory	
		Occurencies	1	
density	constant	**Magnitude**	Density	density
		Usage	obligatory	
		Occurencies	1	
emissivity	constant	**Magnitude**	Dimensionless	emissivity
		Usage	obligatory	
		Occurencies	1	

4.2.2 layers

layers

Tag	Type	Parameter	Value	Description
layer	group	**Section**	4.2.2	layer
		Usage	obligatory	
		Occurencies	-1	

layer layer

Tag	Type	Parameter	Value	Description
geometry	group	**Section**	4.2.4	wall geometry
		Usage	obligatory	
		Occurencies	1	
material	reference	**Magnitude**	Dimensionless	material
		Usage	obligatory	
		Occurencies	1	

geometry wall geometry

Tag	Type	Parameter	Value	Description
thickness	constant	**Magnitude**	Length	layer thickness
		Usage	obligatory	
		Occurencies	1	

4.2.3 boundaries

boundaries

Tag	Type	Parameter	Value	Description
boundary	group	**Section**	4.2.3	boundary
		Usage	obligatory	
		Occurencies	-1	

boundary boundary

Tag	Type	Parameter	Value	Description
temperature	constant	**Magnitude**	Temperature	fluid temperature
		Usage	obligatory	
		Occurencies	1	
heat _transfer _coefficient	constant	**Magnitude**	Heat transfer coefficient	Heat transfer coefficient
		Usage	obligatory	
		Occurencies	1	
velocity	constant	**Magnitude**	Velocity	Fluid velocity
		Usage	obligatory	
		Occurencies	1	
heat_flux	constant	**Magnitude**	Heat flux	Heat flux
		Usage	obligatory	
		Occurencies	1	
infrared _irradiance	constant	**Magnitude**	Heat flux	infrared irradiance
		Usage	obligatory	
		Occurencies	1	
solar _irradiance	constant	**Magnitude**	Heat flux	solar irradiance
		Usage	obligatory	
		Occurencies	1	

4.2.4 geometry

wall geometry

Tag	Type	Parameter	Value	Description
height	constant	**Magnitude**	Length	wall height
		Usage	obligatory	
		Occurencies	1	
length	constant	**Magnitude**	Length	wall width
		Usage	obligatory	
		Occurencies	1	
tilt	constant	**Magnitude**	Length	wall tilt
		Usage	obligatory	
		Occurencies	1	

4.2.5 position

position

Tag	Type	Parameter	Value	Description
latitude	constant	**Magnitude**	Angle	latitude
		Usage	obligatory	
		Occurencies	1	
longitude	constant	**Magnitude**	Angle	longitude
		Usage	obligatory	
		Occurencies	1	
orientation	constant	**Magnitude**	Angle	orientation
		Usage	obligatory	
		Occurencies	1	
date	constant	**Magnitude**	Date	date
		Usage	obligatory	
		Occurencies	1	
time	constant	**Magnitude**	Time	time
		Usage	obligatory	
		Occurencies	1	

4.3 output

output parameters

Tag	Type	Parameter	Value	Description
screen	group	**Section**	4.3.1	Screen output parameters.
		Usage	obligatory	
		Occurencies	1	
file	group	**Section**	4.3.2	File output parameters.
		Usage	obligatory	
		Occurencies	1	

4.3.1 screen

Screen output parameters.

Tag	Type	Parameter	Value	Description
time_step	constant	**Magnitude**	Time	time step
		Usage	obligatory	
		Occurencies	1	
space_step	constant	**Magnitude**	Length	space step
		Usage	obligatory	
		Occurencies	1	

4.3.2 file

File output parameters.

Tag	Type	Parameter	Value	Description
time_step	constant	**Magnitude**	Time	time step
		Usage	obligatory	
		Occurencies	1	

Chapter 5

Output file

All results are exported in SI units

Column	Title	Unit	Description
1	time	s	Time
2	Civ.time	s	Civilian time
3	Sol.time	s	Solar time
4	qconv1	$\frac{W}{m^2}$	Heat flux due to convection at side 1
5	qrad1	$\frac{W}{m^2}$	Heat flux due to ambient radiation at side 1
6	qsol1	$\frac{W}{m^2}$	Heat flux due to solar radiation at side 1
7	qconv2	$\frac{W}{m^2}$	Heat flux due to convection at side 1
8	qrad2	$\frac{W}{m^2}$	Heat flux due to ambient radiation at side 1
9	qsol2	$\frac{W}{m^2}$	Heat flux due to solar radiation at side 1
10	hcon1	$\frac{W}{m^2K}$	Heat transfer coefficient due to convection at side 1

Column	Title	Unit	Description
11	hrad1	$\frac{W}{m^2K}$	Heat transfer coefficient due to convection at side 1
12	hconv2	$\frac{W}{m^2K}$	Heat transfer coefficient due to ambient radiation at side 1
13	hrad2	$\frac{W}{m^2K}$	Heat transfer coefficient due to ambient radiation at side 1
14	$\mathcal{Q}$cum1	$\frac{J}{m^2}$	Cumulative heat flux through side 1 since start of simulation
15	$\mathcal{Q}$cum2	$\frac{J}{m^2}$	Cumulative heat flux through side 2 since start of simulation
16	Ta(-. . .)	K	Fluid temperature at side 1. Position is indicative.
16 + 1	Ts(0mm)	K	Surface temperature at side 1
. . .			
16 + i	Ts(. . .)	K	Solid temperature at indicated position.
. . .			
16 + N	Ts(. . .)	K	Surface temperature at side 2
16 + N + 1	Ta(. . .)	K	Fluid temperature at side 2. Position is indicative.

Chapter 6

Illustrative examples

Chapter 7

Error messages

Bibliography

[1] Abdel-Wahed, R. M., Patankar, S. v., and Sparrow, E. M. (1976). Fully Developed Laminar Flow and Heat Transfer in a Square Duct with One Moving Wall, *Lett. Heat Mass Transfer*, vol. 3, p. 355.