TTNP201-Transfer thermal with conductivity dependant on Summarized

time:

This test consists in imposing a variable conductivity during function of time a heat transfer. One applies to an edge of the wall an imposed flux condition and on opposite edge the temperature remains constant. Conductivity increases with time and one observes a jump of temperature on edge where flux is imposed.

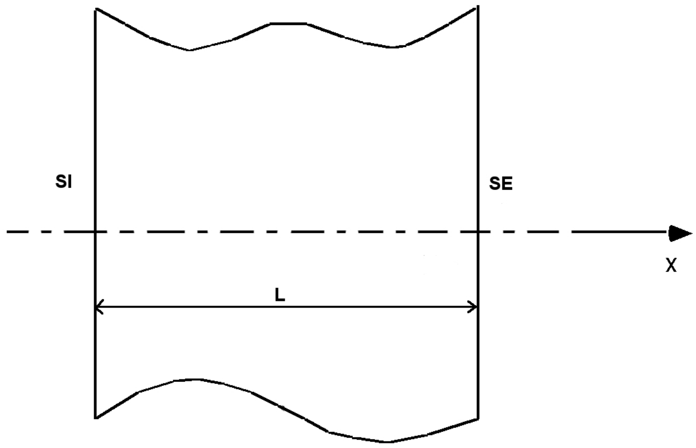
With the problem is dealt out of `PLANE`, `AXIS` and `3D`.
The reference solution is obtained by the iterative method of Crank-Nicholson.

One tests the taking into account of a conductivity function of time.

1 Problem of reference

1.1 Geometry

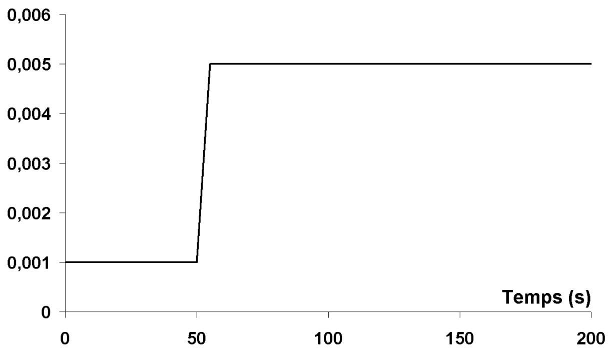
One considers a wall of thickness $L=2m$.



1.2 Properties of the material

the thermal properties are:

- $\rho Cp=1 J/m^3 °C$
- $\lambda(W/m°C)$ vary as follows:



1.3 Boundary conditions and loadings

On edge SI, one imposes a flux cooling of $-1 W/m^2$.
On edge SE, one imposes a temperature of $100 °C$.

1.4 Initial conditions

At initial time, the temperature is uniform and equal to $100 °C$.

1.5 Temporal discretization

The computation proceeds on $200\mathrm{s}$ with time step: $0{,}1\,s$ between 0 and $40\mathrm{s}$ then $0{,}05\,s$ enters $40\mathrm{s}$ and $80\mathrm{s}$ finally $0{,}1\,s$ until $200\mathrm{s}$.

2 Reference solution

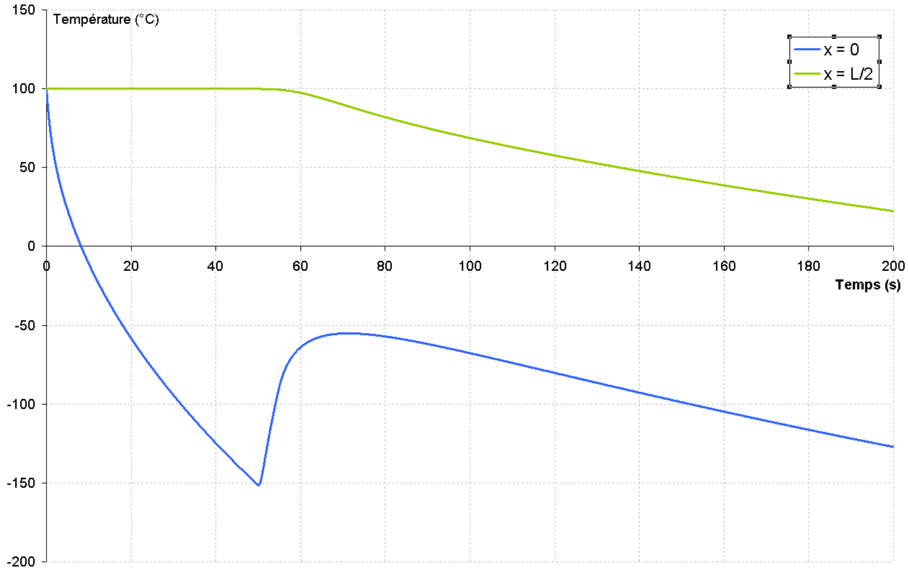
2.1 Method of calculating

It is necessary to solve: $\rho\, Cp \dfrac{dT(x,t)}{dt} = \lambda(t) \dfrac{dT(x,t)}{dx}$ with the initial condition $T(x,0)=100$ and the boundary conditions: $-\lambda(t) \left.\dfrac{\partial T}{\partial x}\right|_{x=0} = -1$ and $T(L,t)=100$

One solves this differential equation with an iterative diagram of Crank-Nicholson [1] under scilab.

2.2 Quantities and results of reference

One observes the temperature with edge $x=0$ and in the middle of the wall $x=\dfrac{L}{2}$. When conductivity increases between 50 and 55 seconds, the temperature in the medium decreases more quickly. The waste heat is propagated towards edges where a warming is observed. This phenomenon is also observed during computation of drying when the coefficient of diffusion depends on the temperature. A d-humidification of edge then is seen.



For the reference of the case test, one records the values of the temperature in $x=0$ and $x=\dfrac{L}{2}$ at various times corresponding to the appearance of the jump of temperature to the peak and computation.

	50s	51s	72s	200s
x=0	0.0000	0.0000	0.0000	0.0000
x=L/2	0.0000	Not tested	0.0000	0.0000

2.3 Uncertainties on the solution

the method of resolution requires steps in times and space sufficiently small to collect the peak of temperature correctly. Here one used $dx=0{,}05\,m$ and $dt=0{,}01\,s$.

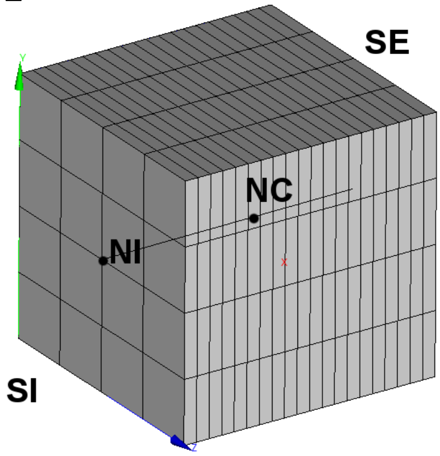
2.4 Bibliographical references

[1] J. Crank, The mathematics of diffusion, Oxford University Close, second edition 1975.

3 Modelization A

3.1 Characteristic of the modelization

One uses a modelization 3D_DIAG.



3.2 Characteristics of the mesh

The mesh contains 320 elements of the type HEXA8.

3.3 Quantities tested and Standard

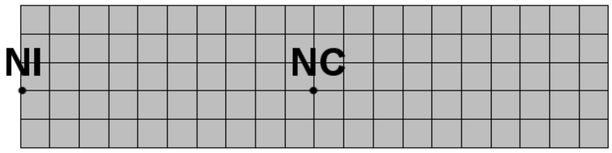
Identification	results of reference	Value of reference	Tolerance
Not Ni - *TEMP*	"SOURCE_EXTERNE"		
t=50s		-151.52	2.00%
t=51s		-143.51	2.00%
t=72s		-55.17	0.50%
t=200s		-127.18	0.50%
Point NC - *TEMP*	"SOURCE_EXTERNE"		
t=50s		99.85	0.50%
t=72s		88.24	0.50%
t=200s		22.43	0.50%

the values obtained with *Code_Aster* in version 10.3.18 are tested in "NON_REGRESSION" with an accuracy of $0,1\%$.

4 Modelization B

4.1 Characteristic of the modelization

One uses a modelization PLAN_DIAG.



4.2 Characteristics of the mesh

The mesh contains 100 elements of the type QUAD4.

4.3 Quantities tested and Standard

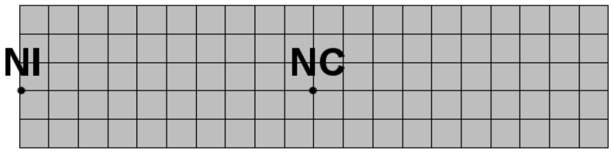
Identification	results of reference	Value of reference	Tolerance
Not Ni - *TEMP*	"SOURCE_EXTERNE"		
t=50s		-151.52	2.00%
t=51s		-143.51	2.00%
t=72s		-55.17	0.50%
t=200s		-127.18	0.50%
Point NC - *TEMP*	"SOURCE_EXTERNE"		
t=50s		99.85	0.50%
t=72s		88.24	0.50%
t=200s		22.43	0.50%

the values obtained with *Code_Aster* in version 10.3.18 are tested in "NON_REGRESSION" with an accuracy of $0{,}1\%$.

5 Modelization C

5.1 Characteristic of the modelization

One uses a modelization AXIS_DIAG.



5.2 Characteristics of the mesh

The mesh contains 100 elements of the type QUAD4.

5.3 Quantities tested and Standard

Identification	results of reference	Value of reference	Tolerance
Not Ni - $TEMP$	"SOURCE_EXTERNE"		
t=50s		-151.52	2.00%
t=51s		-143.51	2.00%
t=72s		-55.17	0.50%
t=200s		-127.18	0.50%
Point NC - $TEMP$	"SOURCE_EXTERNE"		
t=50s		99.85	0.50%
t=72s		88.24	0.50%
t=200s		22.43	1.00%

the values obtained with *Code_Aster* in version 10.3.18 are tested in "NON_REGRESSION" with an accuracy of $0,1\%$.

6 Summary of the results

the quality of the results is satisfactory, one represents the peak of temperature to edge. The errors compared to the remain lower $1{,}6\%$ than reference solution. The results can be improved by a temporal and spatial refinement.