TPNL300 - Unidimensional heat transfer with Summarized

radiation:

This test is resulting from the validation independent of version 3 in nonlinear steady thermal.

It is about a problem 1D linear represented by two modelizations, one planes, the other voluminal one.

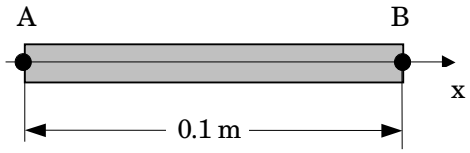
The features tested are the following ones:
•plane thermal element,
•voluminal thermal element,
•limiting conditions: (imposed temperatures, radiation).

The interest of the test lies in the taking into account of the radiation.

The results are compared with those provided by NAFEMS.

1 Problem of reference

1.1 Geometry



1.2 Properties of the thermal

$\lambda = 55.6\, W/m\,°C$ material Conductivity
$c = 460.\, J/kg\,°C$ Specific heat
$\rho = 7850.\, kg/m^3$ Density

1.3 Boundary conditions and loadings

- temperature imposed on point: A $T_A = 726.85\,°C$,
- exchange by radiation with point: B
  - outside temperature $T_e = 26.85\,°C$,
  - $\varepsilon = 0.98$ emissivity,
  - $\sigma = 5.67.10^{-8}\, W/m^2\, K^4$ (constant of Stefan-Boltzmann).

1.4 Initial conditions

Without object.

2 Reference solution

2.1 Méthode de calcul used for the reference solution

the reference solution is that given in file “TEST n°2” of the tests of reference published by NAFEMS.

2.2 Results of reference

Temperature to point: $B \quad T = 653.85\,°C$

2.3 Uncertainty on the solution

Nonavailable on file NAFEMS.

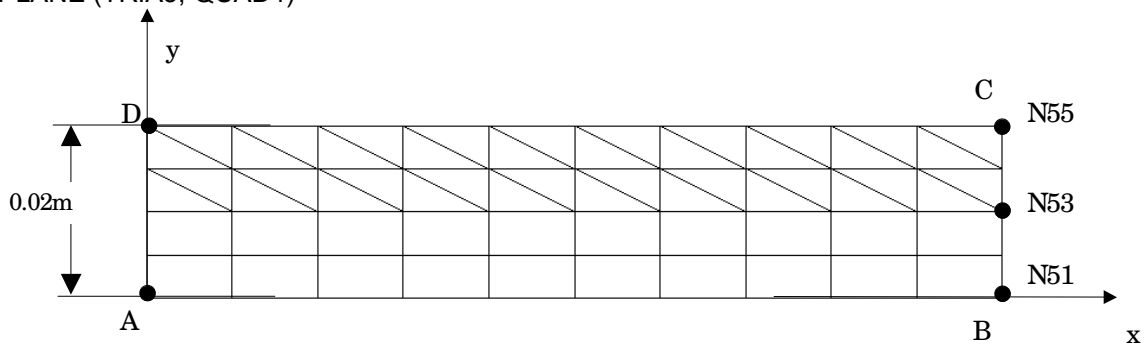
2.4 Bibliographical references

•NAFEMS (the National Agency for Finite Element Methods Standard and (the U.K.)): “Standard The NAFEMS Benchmarcks”, TNSB rév 3, October 1990.

3 Modelization A

3.1 Characteristic of the modelization

PLANE (TRIA3, QUAD4)



Conditions aux limites:

- Coté AD: T = 726.85°C
- Cotés AB, CD: φ = 0
- Coté BC: T_{ext}=26.85°C
  ε = 0.98

3.2 Characteristic of the mesh

Many nodes: 55
Number of meshes and types: 60: (20 QUAD4, 40 TRIA3)

4 Results of the modelization A

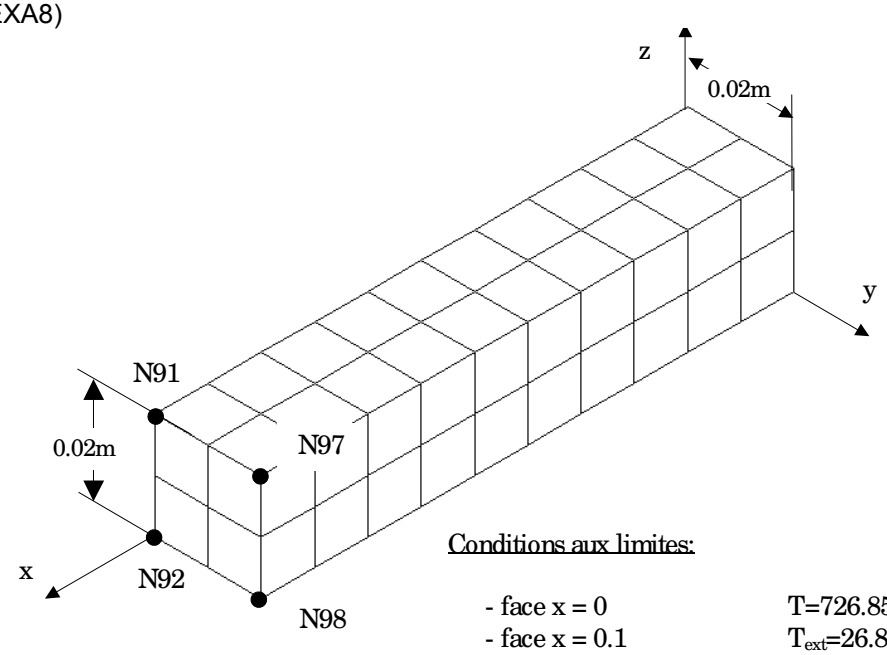
4.1 Values tested

Identification	Reference	*Aster*	% difference	tolerance
Temperature to the point B in °C				
N51	653.85	653.87	0.003	2%
N53	653.85	653.87	0.003	2%
N55	653.85	653.87	0.003	2%

5 Modelization B

5.1 Characteristic of the modelization

3D (HEXA8)



Conditions aux limites:

- face x = 0	T=726.85°C
- face x = 0.1	T_{ext}=26.85°C
	ε = 0.98
- autres faces	φ = 0

5.2 Characteristic of the mesh

Many nodes:	99
Number of meshes and types:	40 HEXA8

6 Results of the modelization B

6.1 Values tested

Identification	Reference	*Aster*	% difference	tolerance
Temperature to the point B in °C				
N91	653.85	653.87	0.003	2%
N92	653.85	653.87	0.003	2%
N97	653.85	653.87	0.003	2%
N98	653.85	653.87	0.003	2%

7 Summary of the results

This test are recommended by NAFEMS (but with another type of mesh).
The two modelizations give very satisfactory results, the maximum change obtained is of 0.003%.

For the modelization PLANE, in spite of nonthe - symmetry of the mesh, one notes that the temperature with nodes (points of observation) belonging to TRIA3 and with the QUAD4 is identical.

The limiting condition of radiation was imposed via a nonlinear flux loading (flux function of the temperature). In this test the taking into account of the radiation is completely correct.

This test with license to test the command AFFE_CHAR_THER_F (associate with operand FLUX_NL which makes it possible to affect a flux non_linéaire) in the PLANE case of modelizations and 3D.