TPLS100 - Infinite plate subjected to antisymmetric flows

Summary:

The purpose of this test is to test the model of thermal hull linear with three fields (MODELING: 'HULL' or 'COQUE_PLAN') by comparison with an analytical solution, for an infinite plate subjected to a couple of stationary antisymmetric heat flows on its two half-faces, in stationary mode.

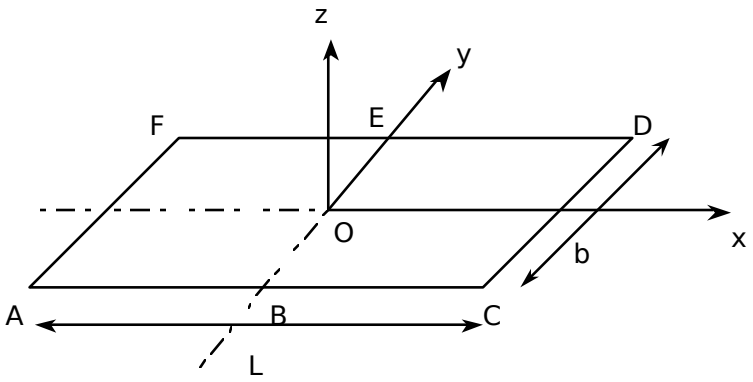
The equation of heat is solved in hover, with a linear, isotropic, homogeneous conduction.

Two modelings: With for the finite elements of surface hull (triangles) and B for the linear elements (segments).

One simultaneously tests in each modeling the elementary orders and the total order THER_LINEAIRE.

1 Problem of reference

1.1 Geometry



Length: $L=20\text{mm}$

Width: $b=2\text{mm}$

Thickness: $h=4\text{mm}$

1.2 Material properties

Conductivity $\lambda=4.5\,W/mm/°C$

Voluminal heat: $\rho C_P=0.J/°C.mm^3$

1.3 Boundary conditions and loadings

Worthless temperature on the average layer of the plate:	$TEMP=0.$
Flow imposed on the upper surface $(ABEF)^+$	$flux^+=30.W/mm^2/°C$
Flow imposed on the upper surface $(ABEF)^-$	$flux^-=-30.W/mm^2/°C$

2 Reference solution

2.1 Method of calculating used for the reference solution

Analytical

For more details to refer to the document [R3.11.01] and the note [bib1].

2.2 Results of reference

- Temperature in higher skin,
- Flow into cubes nodes placed on the axis Ox in higher skin.

2.3 Uncertainty on the solution

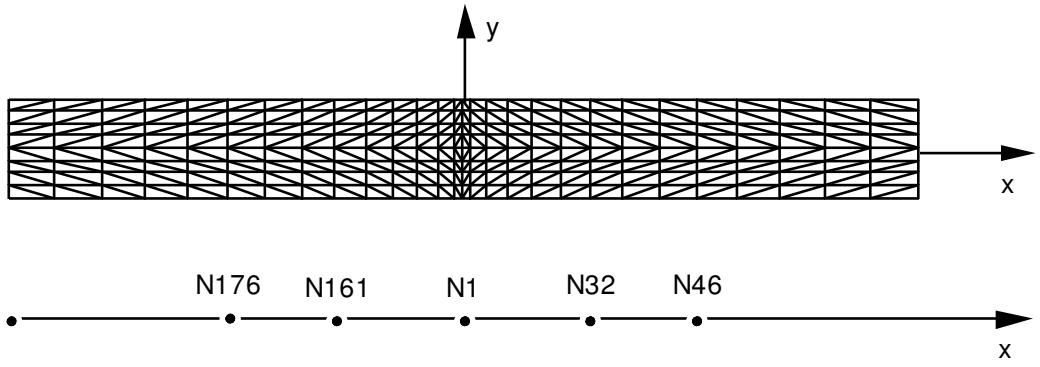
Analytical solution.

2.4 Bibliographical references

- S. ANDRIEUX, F. VOLDOIRE HI-71/7131 - Formulation of a model of thermics for the thin hulls (12/7/90).

3 Modeling A

3.1 Characteristics of modeling



Cutting: 28 elements in length,
8 elements in width.

Boundary conditions - loading:

```
TEMP_IMPO (ALL = ' oui', TEMP=0.)
FLUX_REP (GROUP_MA =GRSD2, FLUN_INF=-30.
                           FLUN_SUP=30.)
```

3.2 Characteristics of the grid

Many nodes: 969

Many meshs and types: 448 meshs TRIA6

3.3 Sizes tested and results

Identification	Reference
TEMP_SUP :	
node $N201$ $(-10.,0)$	13.3321
node $N176$ $(-5.15,0)$	13.2565
node $N161$ $(-2.8,0)$	12.7462
node $N1$ $(0.,0.)$	6.6666
node $N32$ $(28,0.25)$	0.5870
node $N46$ $(5.15,0)$	0.07679
Flow component X :	
node $N176$	
mesh $M297$	0.2992
mesh $M289$	0.2992
mesh $M290$	0.2992
median value	0.2992
node $N161$	
mesh $M265$	2,287
mesh $M266$	2,287
mesh $M273$	2,287
median value	2,287
node $N1$	
mesh $M1$	25.98
mesh $M225$	25.98

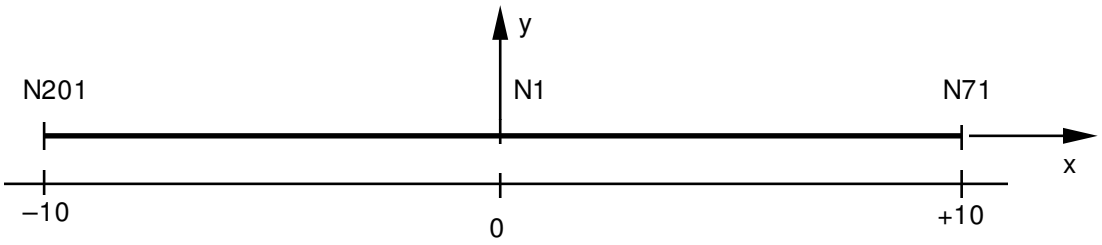
mesh $M337$	25.98
median value	25.98

Contents of the file results

- Temperatures with the nodes,
- heat flow to the nodes in higher wall,
- values tested deferred above.

4 Modeling B

4.1 Characteristics of modeling



Cutting: 28 linear elements in length, (even progression of meshs that in the grid of modeling A).

Boundary conditions - loading:

```
TEMP_IMPO (ALL = ' oui', TEMP=0.)
FLUX_REP (GROUP_MA = GRSD2,   FLUX_INF=-30.
                              FLUX_SUP=30.)
```

4.2 Characteristics of the grid

Many nodes: 57

Many meshs and types: 28 meshs SEG3

4.3 Sizes tested and results

Identification	Reference
TEMP_SUP:	
node $N201$ $(-10.,0)$	13.3321
node $N176$ $(-5.15,0)$	13.2565
node $N161$ $(-2.8,0)$	12.7462
node $N1$ $(0.,0.)$	6.6666
node $N46$ $(5.15,0)$	0.07679

Contents of the files results

- Temperatures with the nodes on the upper surface,
- values tested deferred above.

5 Summary of the results

In modeling A with meshs TRIA6, one notes that the variations on flows are lower than 1%, except in the zones where those are very weak.