TPLL01 - Wall infinite plan in linear thermics

Summary:

This case test relates to a calculation of stationary thermics linear. It understands 10 modelings which test the elements 2D and 3D.

This case test is of several interests:

- **for modelings of A with I**, it tests on almost all the elements 3D and 2D (except `2D_AXIS`, `PYRAM` and lumpés), the calculation of the basic options of linear thermics: "rigidity", "mass", exchanges, imposed flow, imposed temperature,
- **in modeling J**, one calculates a cartography of space error via the option `ERTH_ELEM` of `CALC_ERREUR` on which will rest, in a loop Python, the tool of refinement/déraffinement LOBSTER encapsulated in `MACR_ADAP_MAIL`.
- The orientation of the wall is unspecified compared to the axes of coordinates,
- It is one of the rare CAS-tests to test elements TETRA10 and QUAD9 in linear thermics and to combine the orders `AFFE_CHAR_THER/LIAISON_DDL`.

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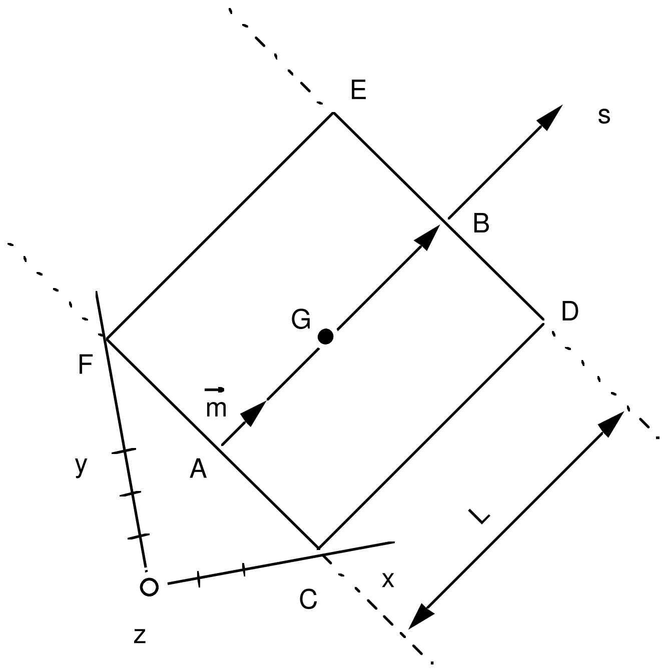
1 Problem of reference

1.1 Geometry



Le problème correspond à un mur infini :
CF et DE quelconque

L = 0.05 m

C = {0.03, 0.0, 0.0}
F = {0.0, 0.04, 0.0}
A = {0.015, 0.02, 0.0}

1.2 Material properties

$\lambda=0.75 W/m\,°C$ Thermal conductivity

$\rho C_P=2. J/m^3\,°C$ Voluminal heat

1.3 Boundary conditions and loadings

- $[FE]$ and $[CD]$: null flow
- $[FA]$: free convection ($h=30 W/m^2\,°C$, $T^e=140\,°C$)
- $[AC]$: imposed temperature $T^i=100\,°C$
- $[ED]$: density flux imposed $\varphi^i=-1\,200 W/m^2$, (outgoing flow)

1.4 Initial conditions

To do this stationary calculation, one does a transitory calculation (except for modelings A and G) for which the boundary conditions are constant in time. This makes it possible to test elementary calculations of mass intervening in the first member as well as the second member.

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2 Reference solution

2.1 Method of calculating used for the reference solution

$$T(s)=T_A+(T_B-T_A).\frac{s}{L} \quad S=\overline{AM} \quad M \text{ point courant}$$

$$\vec{\varphi}=-\lambda.\frac{T_B-T_A}{L}.\vec{m}$$

2.2 Results of reference

Temperatures and flow at the points A , B , G .

2.3 Uncertainty on the solution

Analytical solution.

2.4 References

Case test VPCS TPLL01.

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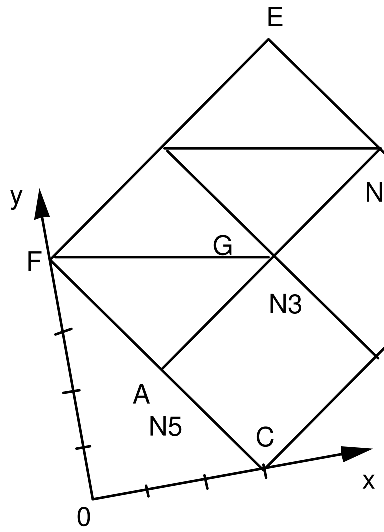
3 Modeling A

3.1 Characteristics of modeling

Plan (QUAD4, TRIA3)

One nets part of the infinite wall, such as the field is a square $\overline{DE}=\overline{CF}=L$ with 4 meshs TRIA3 and 2 meshs QUAD4.



	x	y	
C	0.03	0	
D	0.07	0.03	
E	0.04	0.07	
F	0	0.04	
A	0.015	0.02	N5
B	0.055	0.05	N1
G	0.035	0.035	N3

3.2 Characteristics of the grid

Many nodes: 9

Many meshs and types: 2 QUAD4, 4 TRIA3

3.3 Remarks

To test the keyword factor `LIAISON_DDL`, the linear relation was introduced (checked by the solution): $T(G)-T(B)=40.$

3.4 Values tested

Identification	Reference
$T(A)°C$	100.
$T(B)°C$	20.
$T(G)°C$	60.
$\vec{\varphi}(m).\vec{i}\ (\forall m)\ W/m^2$	960.
$\vec{\varphi}(m).\vec{j}\ (\forall m)\ W/m^2$	720.

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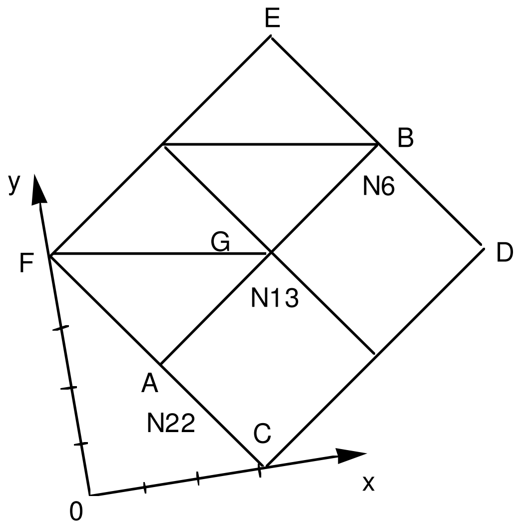
4 Modeling B

4.1 Characteristics of modeling

Plan (QUAD8, TRIA6)



	x	y	
C	0.03	0	
D	0.07	0.03	
E	0.04	0.07	
F	0	0.04	
A	0.015	0.02	N22
B	0.055	0.05	N6
G	0.035	0.035	N13

4.2 Characteristics of the grid

Many nodes: 23

Many meshs and types: 4 TRIA6, 2 QUAD8

4.3 Notice

To test the keyword factor LIAISON_DDL , the linear relation was introduced (checked by the solution) $T(G)-T(B)=40$.

4.4 Values tested

Identification	Reference
$T(A)°C$	100.
$T(B)°C$	20.
$T(G)°C$	60.
$\vec{\varphi}(m).\vec{i}\ (\forall m)\ W/m^2$	960.
$\vec{\varphi}(m).\vec{j}\ (\forall m)\ W/m^2$	720.

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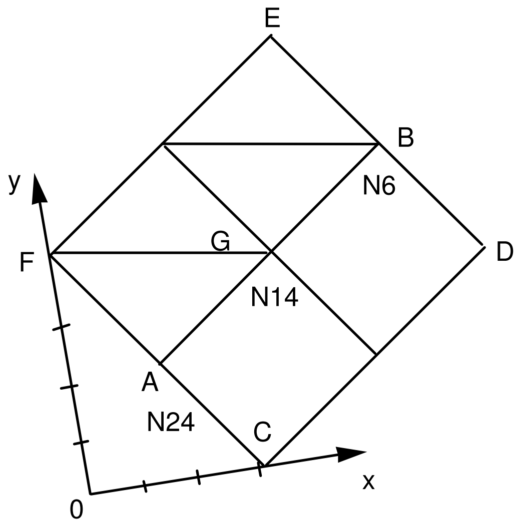
5 Modeling C

5.1 Characteristics of modeling

Plan (QUAD8, TRIA6)



	x	y	
C	0.03	0	
D	0.07	0.03	
E	0.04	0.07	
F	0	0.04	
A	0.015	0.02	N24
B	0.055	0.05	N6
G	0.035	0.035	N14

5.2 Characteristics of the grid

Many nodes: 25

Many meshs and types: 4 TRIA6, 2 QUAD9

5.3 Values tested

Identification	Reference
$T(A)°C$	100.
$T(B)°C$	20.
$T(G)°C$	60.
$\vec{\varphi}(m).\vec{i}\ (\forall m)\ W/m^2$	960.
$\vec{\varphi}(m).\vec{j}\ (\forall m)\ W/m^2$	720.

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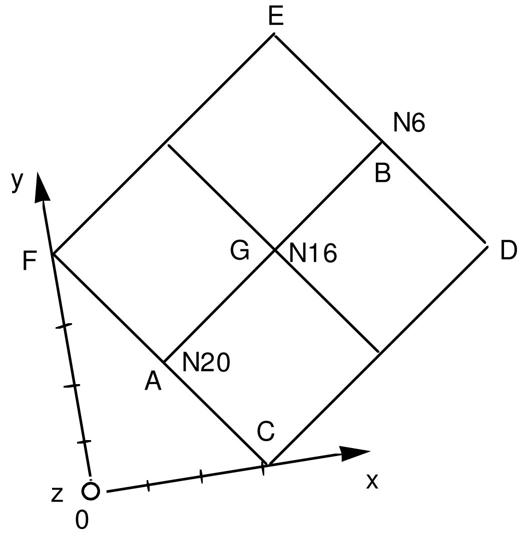
6 Modeling D

6.1 Characteristics of modeling

Voluminal (HEXA8)



	x	y	z	
C	0.03	0	0	
D	0.07	0.03	0	
E	0.04	0.07	0	
F	0	0.04	0	
A	0.015	0.02	0	N20
B	0.055	0.05	0	N6
G	0.035	0.035	0	N16

6.2 Characteristics of the grid

Many nodes: 21

Many meshs and types: 4 HEXA8 + 20 QUAD4

6.3 Values tested

Identification	Reference
$T(A)°C$	100.
$T(B)°C$	20.
$T(G)°C$	60.
$\vec{\varphi}(m).\vec{i}\ (\forall m)\ W/m^2$	960.
$\vec{\varphi}(m).\vec{j}\ (\forall m)\ W/m^2$	720.

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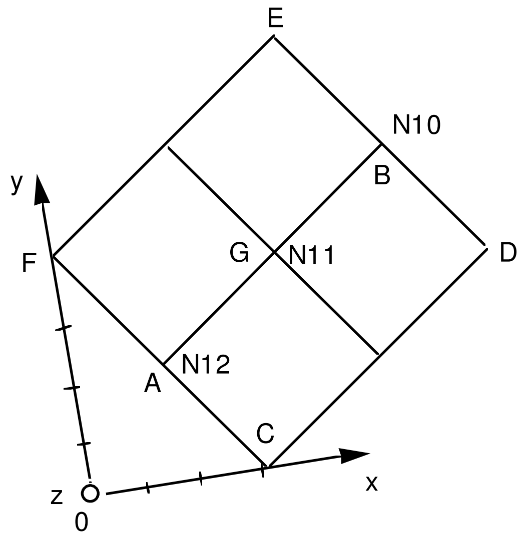
7 Modeling E

7.1 Characteristics of modeling

Voluminal (PENTA6)



	x	y	z	
C	0.03	0	0	
D	0.07	0.03	0	
E	0.04	0.07	0	
F	0	0.04	0	
A	0.015	0.02	0	N12
B	0.055	0.05	0	N10
G	0.035	0.035	0	N11

7.2 Characteristics of the grid

Many nodes: 21

Many meshs and types: 8 PENTA6 + 8 TRIA3 + 16 QUAD4

7.3 Values tested

Identification	Reference
$T(A)°C$	100.
$T(B)°C$	20.
$T(G)°C$	60.
$\vec{\varphi}(m).\vec{i}\ (\forall m)\ W/m^2$	960.
$\vec{\varphi}(m).\vec{j}\ (\forall m)\ W/m^2$	720.

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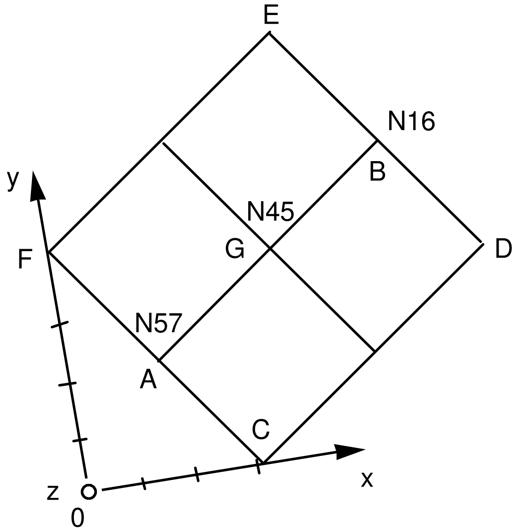
8 Modeling F

8.1 Characteristics of modeling

Voluminal (HEXA20)



	x	y	z	
C	0.03	0	0	
D	0.07	0.03	0	
E	0.04	0.07	0	
F	0	0.04	0	
A	0.015	0.02	0	N57
B	0.055	0.05	0	N16
G	0.035	0.035	0	N45

8.2 Characteristics of the grid

Many nodes: 59

Many meshs and types: 4 HEXA20 + 20 QUAD8

8.3 Values tested

Identification	Reference
$T(A)°C$	100.
$T(B)°C$	20.
$T(G)°C$	60.
$\vec{\varphi}(m).\vec{i}\ (\forall m)\ W/m^2$	960.
$\vec{\varphi}(m).\vec{j}\ (\forall m)\ W/m^2$	720.

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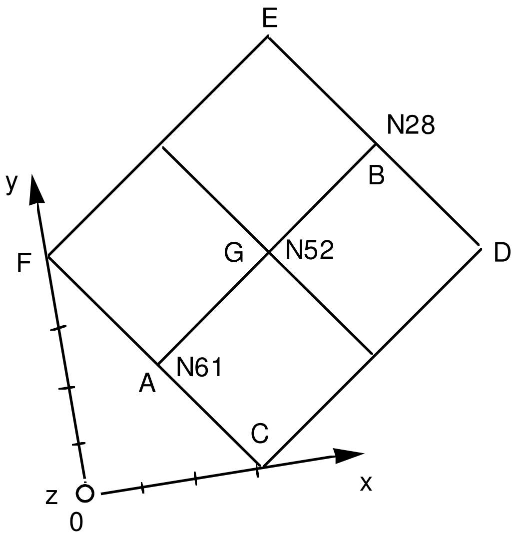
9 Modeling G

9.1 Characteristics of modeling

Voluminal (PENTA15)



	x	y	z	
C	0.03	0	0	
D	0.07	0.03	0	
E	0.04	0.07	0	
F	0	0.04	0	
A	0.015	0.02	0	N61
B	0.055	0.05	0	N28
G	0.035	0.035	0	N52

9.2 Characteristics of the grid

Many nodes: 65

Many meshs and types: 8 PENTA15 + 8 TRIA6 + 16 QUAD8

9.3 Values tested

Identification	Reference
$T(A)°C$	100.
$T(B)°C$	20.
$T(G)°C$	60.
$\vec{\varphi}(m).\vec{i}\ (\forall m)\ W/m^2$	960.
$\vec{\varphi}(m).\vec{j}\ (\forall m)\ W/m^2$	720.

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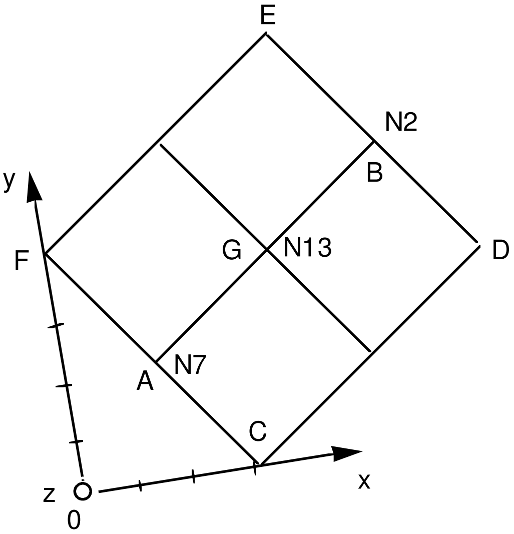
10 Modeling H

10.1 Characteristics of modeling

Voluminal (TETRA4)



	x	y	z	
C	0.03	0	0	
D	0.07	0.03	0	
E	0.04	0.07	0	
F	0	0.04	0	
A	0.015	0.02	0	N7
B	0.055	0.05	0	N2
G	0.035	0.035	0	N13

10.2 Characteristics of the grid

Many nodes: 18

Many meshs and types: 20 TETRA4 + 6 TRIA3 + 16 QUAD8

10.3 Values tested

Identification	Reference
$T(A)°C$	100.
$T(B)°C$	20.
$T(G)°C$	60.
$\vec{\varphi}(m).\vec{i}\ (\forall m)\ W/m^2$	960.
$\vec{\varphi}(m).\vec{j}\ (\forall m)\ W/m^2$	720.

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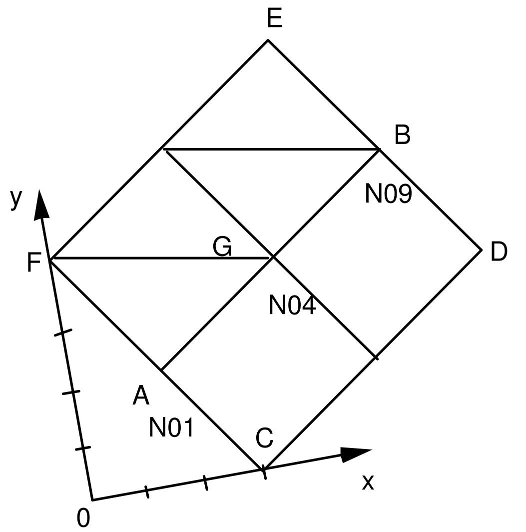
11 Modeling I

11.1 Characteristics of modeling

Voluminal (TETRA10)



	x	y	
C	0.03	0	
D	0.07	0.03	
E	0.04	0.07	
F	0	0.04	
A	0.015	0.02	N01
B	0.055	0.05	N09
G	0.035	0.035	N04

11.2 Characteristics of the grid

Many nodes: 125

Many meshs and types: 48 TETRA10 + 16 TRIA6

11.3 Values tested

Identification	Reference
$T(A)°C$	100.
$T(B)°C$	20.
$T(G)°C$	60.
$\vec{\varphi}(m).\vec{i}\ (\forall m)\ W/m^2$	960.
$\vec{\varphi}(m).\vec{j}\ (\forall m)\ W/m^2$	720.

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12 Modeling J

12.1 Characteristics of modeling

It is of a case functional test and data-processing not-regression of the calculation of the indicator of error established a posteriori in thermics (cf [R4.10.03]). He exhumes a cartography of space error on which will be based, in a loop Python, the tool of refinement/déraffinement LOBSTER encapsulated in MACR_ADAP_MAIL (cf [U7.03.01]).
The calculation of this map of indicator of error is carried out, via the option 'ERTH_ELEM'L' operator of postprocessing CALC_ERREUR, on one EVOL_THER (provides to the keyword RESULT) coming from a former thermal calculation (linear or not, transient or stationary, isotropic or orthotropic, via THER_LINEAIRE or THER_NON_LINE, cf environment necessary, parameter setting and perimeter of use [R4.10.03] §6.2/4).
This calculation requires the recourse to the option as a preliminary 'FLUX_ELNO' of CALC_CHAMP who determines the values of the vector heat flux to the nodes (cf example of use [R4.10.03] §6.5).
The indicator consists of fifteen components per element and for a given moment. In this case test, one calculates the fifteen components but the procedure of refinement/déraffinement is pressed only on the component ERTABS who represents the absolute total space error (cf [R4.10.03] §6.3).
In order to be able post-to treat via POST_RELEVE or GIBI, one needs to extrapolate fields by element into cubes fields with the nodes by element. The addition of the option 'ERTH_ELNO_ELEM'(after L' call to 'ERTH_ELEM_TEMP') allows to carry out this purely data-processing transformation. For one moment and a given finite element, it does nothing but duplicate the fifteen components of the indicator on each node of the element.
This modeling thus constitutes as much an example of use, in a loop PYTHON, possible couplings "calculation of indicator"/"refinement/déraffinement of grid", that a case test of not-regression of the options 'ERTH_ELEM_TEMP' and 'ERTH_ELNO_ELEM' and their adherence with the process of mending of meshes.
This case test takes again the characteristics of modeling I and its grid (TETRA10 + TRIA6) associated.

12.2 Values tested

One tests the data-processing not-regression of component ERTREL (relative total space error) of the indicator of error compared to the V6.2.1 versions of platforms SGI and SUN of *Code_Aster* and of the V4.3 version of the software LOBSTER. The relative tolerance is thus severe: 5.10^{-6} %.

Identification	***Aster***	**Tolerance**
Value of ERTREL on the mesh MA1 before mending of meshes	$4.15918735\ 10^{-5}$	5.10^{-8}
Value of ERTREL on the node NO4 before mending of meshes	$4.15918735\ 10^{-5}$	5.10^{-8}
Value of ERTREL on the mesh M1 after mending of meshes	$5.48408914\ 10^{-6}$	5.10^{-7}

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13 Summary of the results

The field solution (linear) belongs to the space of interpolation of all the elements tested. The results are thus naturally excellent.

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