TPLV101 - Stationary thermics with condition of exchange between walls in opposite

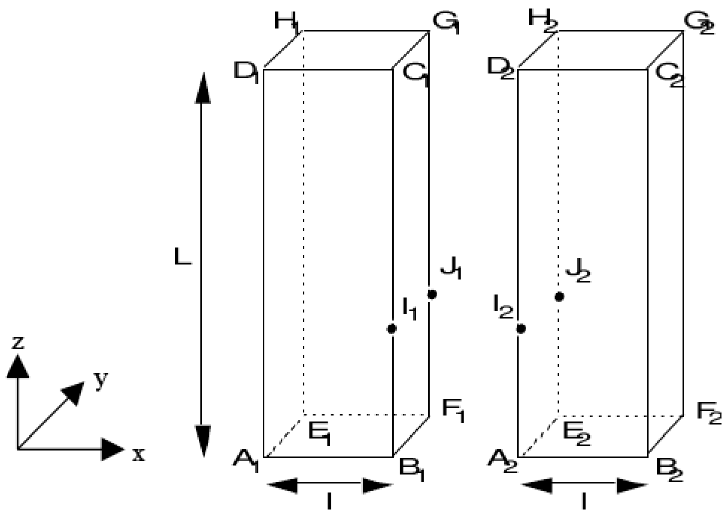
Summary:

This elementary test makes it possible to deal with a stationary problem in thermics bringing into play two fields separated by imposing a boundary condition of the type exchanges between walls.

For modelings presented here, the results got by *Code_Aster* are identical to the analytically calculated reference.

1 Problem of reference

1.1 Geometry



Height $L=3.m$
Width $l=1.m$

1.2 Material properties

Voluminal heat $\rho C_P=0.$
Thermal conductivity $k=1.\mathrm{W}/m°C$

1.3 Boundary conditions and loadings

Outgoing flow through the plan $B_1F_1G_1C_1$ identical to flow entering through the plan $A_2E_2H_2D_2$	
Temperature imposed in A_1	$T=0.°C$
Temperature imposed in B_2	$T=4.5°C$
Normal flow imposed on the plan $B_2F_2G_2C_2$	$\varphi=3.\mathrm{W}/m^2$
Normal flow imposed on the plans $C_1G_1H_1D_1$ and $C_2G_2H_2D_2$	$\varphi=6.\mathrm{W}/m^2$
Normal flow imposed on the plans $E_1F_1G_1H_1$ and $E_2F_2G_2H_2$	$\varphi=2.\mathrm{W}/m^2$
Source imposed in field 1	s_1
Source imposed in field 2	s_2

2 Reference solution

2.1 Method of calculating used for the reference solution

One has a simple analytical solution, since it is a question of displaying a harmonic function and of adjusting the source associated in each field:

- in field 1: $T(x, y, z) = T(A_1) + x^2 + y^2 + z^2$, (in the reference mark of origin A_1),
- in field 2: $T(x, y, z) = T(A_2) + \frac{1}{2} x^2 + y^2 + z^2$, (in the reference mark of origin A_2).

One from of deduced the values from s_1 and s_2, $s_1 = -6.$, $s_2 = -5.\mathrm{W}/m^3$.

2.2 Results of reference

Temperatures at the points of the plans $B_1 F_1 G_1 C_1$ and $A_2 E_2 H_2 D_2$

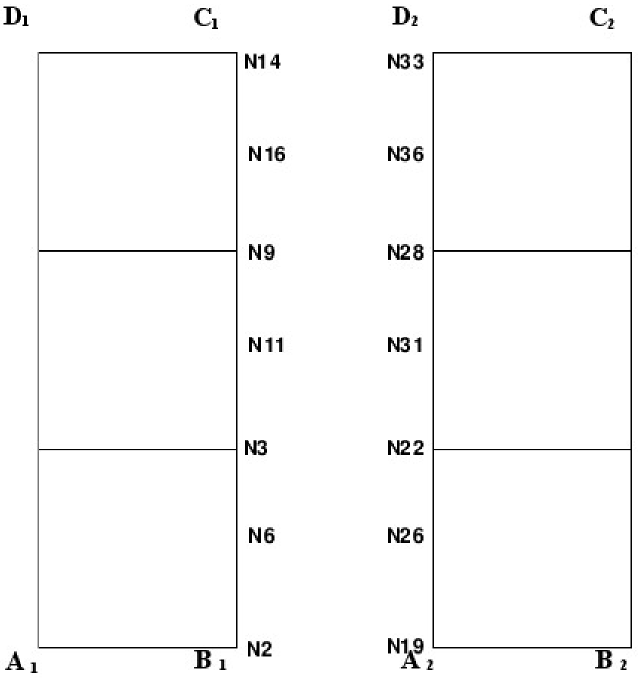
2.3 Uncertainty on the solution

Analytical solution.

3 Modeling A

3.1 Characteristics of modeling

Modeling 2D:



3.2 Boundary conditions and loadings

Outgoing flow through the wall B_1C_1 identical to flow entering through the wall A_2D_2	
Temperature imposed in A_1	$T=0.\,°C$
Temperature imposed in B_2	$T=4.5\,°C$
Normal flow imposed on the wall B_2C_2	$\varphi=3.\mathrm{W}/m^2$
Normal flow imposed on the plans C_1D_1 and C_2D_2	$\varphi=6.\mathrm{W}/m^2$
Source imposed in field 1	s_1
Source imposed in field 2	s_2

3.3 Characteristics of the grid

6 QUAD8
36 nodes

3.4 Values tested

Identification Temperature	Reference
node $N2$ (B_1)	1.00
node $N3$	2.00
node $N6$	1.25
node $N11$	3.25

node $N9$	5.00
node $N16$	7.25
node $N14$ (C_1)	10.00
node $N19$ (A_2)	2.00
node $N22$	3.00
node $N26$	2.25
node $N31$	4.25
node $N28$	6.00
node $N36$	8.25
node $N33$ (D_2)	11.00

3.5 Remarks

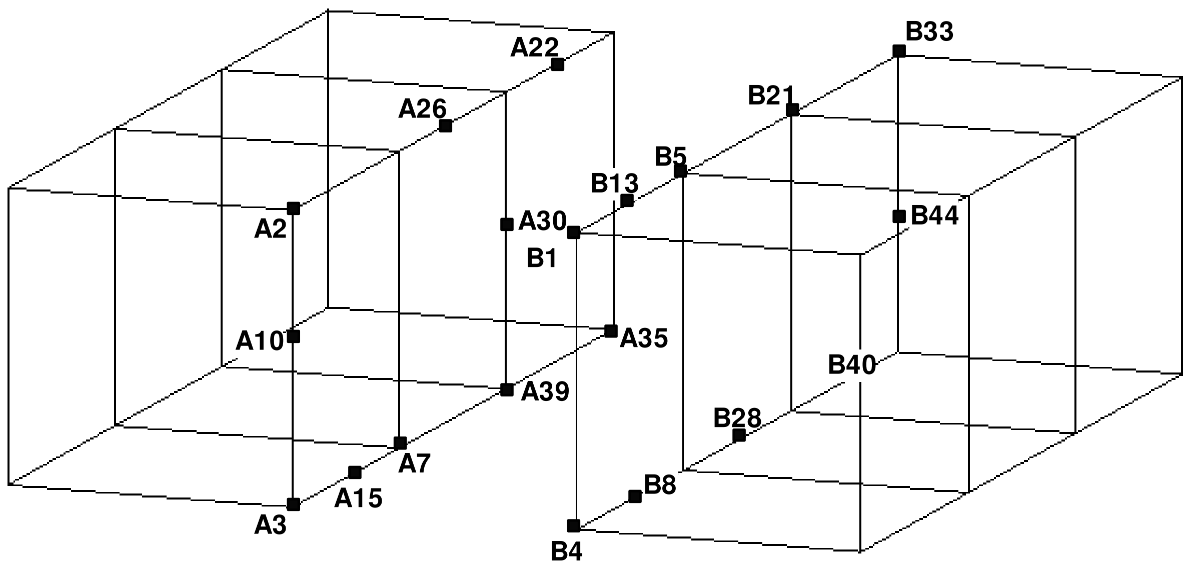
The functions of form of element QUAD8 being of order 2, it is natural to obtain the reference solution which is expressed in the form of a polynomial of order 2.

The command file deposited contains a list of moments and calls the order THER_LINEAIRE to carry out a transitory calculation which is not of interest, the coefficient of voluminal heat being taken equal to 0.

4 Modeling B

4.1 Characteristics of modeling

Modeling 3D:



4.2 Characteristics of the grid

6 HEXA20
88 nodes

4.3 Values tested

Identification Temperature	Reference
node $A2$ (B_1)	1.00
node $A3$ (F_1)	2.00
node $A7$	3.00
node $A10$	1.25
node $A15$	2.25
node $A22$	5.00
node $A26$	3.25
node $A30$	5.25
node $A35$ (G_1)	11.00
node $A39$	8.25
node $B1$ (A_2)	2.00
node $B4$ (E_2)	3.00
node $B5$	3.00
node $B8$	4.00

node $B13$	2.25
node $B21$	6.00
node $B28$	5.25
node $B33$ (D_2)	11.00
node $B40$	9.25
node $B44$	11.25

4.4 Remarks

The functions of form of element HEXA20 being of order 2, it is natural to obtain the reference solution which is expressed in the form of a polynomial of order 2.

The command file deposited contains a list of moments and calls the order `THER_LINEAIRE` to carry out a transitory calculation which is not of interest, the coefficient of voluminal heat being taken equal to 0.

5 Modeling C

5.1 Characteristics of modeling

Modeling is the same one as that of modeling A.

5.2 Boundary conditions and loadings

Outgoing flow through the wall $B_1 C_1$ identical to flow entering through the wall $A_2 D_2$	
Temperature imposed in A_1	$T=0.°C$
Temperature imposed in B_2	$T=4.5°C$
Normal flow imposed on the wall $B_2 C_2$	$\varphi=3.\mathrm{W}/m^2$
Normal flow imposed on the plans $C_1 D_1$ and $C_2 D_2$	$\varphi=6.\mathrm{W}/m^2$
Source imposed in field 1	s_1
Source imposed in field 2	s_2

5.3 Characteristics of the grid

6 QUAD8
36 nodes

5.4 Values tested

Identification Temperature	Reference
node N2 (B_1)	1.00
N3 node	2.00
N6 node	1.25
N11 node	3.25
N9 node	5.00
N16 node	7.25
node N14 (C_1)	10.00
node N19 (A_2)	2.00
N22 node	3.00
N26 node	2.25
N31 node	4.25
N28 node	6.00
N36 node	8.25
node N33 (D_2)	11.00

6 Summaries of the results

Two modelings with elements of order 2 lead in an exact way to the analytical solution and validates the establishment of the boundary conditions of the type ECHANGE_PAROI.