

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

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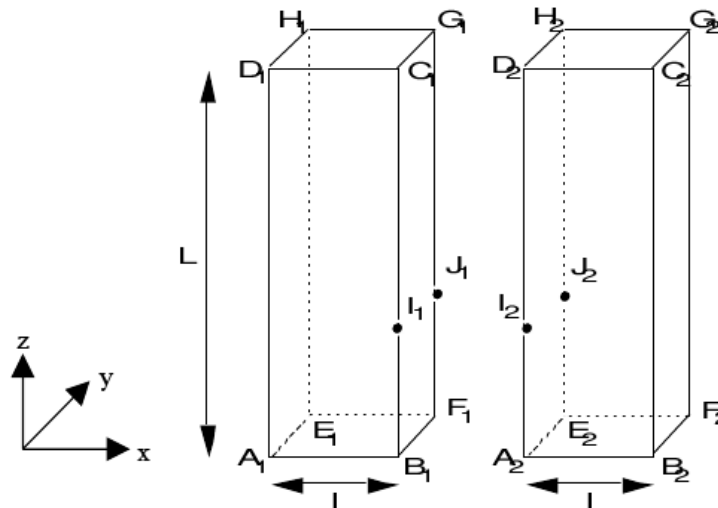
### Summary:

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  $k = 1.W/m^{\circ}C$

### 1.3 Boundary conditions and loadings

Outgoing flow through the plan  $B_1 F_1 G_1 C_1$  identical to flow entering through the plan  $A_2 E_2 H_2 D_2$

Temperature imposed in  $A_1$

$$T = 0.^{\circ}C$$

Temperature imposed in  $B_2$

$$T = 4.5.^{\circ}C$$

Normal flow imposed on the plan  $B_2 F_2 G_2 C_2$

$$\varphi = 3.W/m^2$$

Normal flow imposed on the plans  $C_1 G_1 H_1 D_1$  and  $C_2 G_2 H_2 D_2$

$$\varphi = 6.W/m^2$$

Normal flow imposed on the plans  $E_1 F_1 G_1 H_1$  and  $E_2 F_2 G_2 H_2$

$$\varphi = 2.W/m^2$$

Source imposed in field 1

$$s_1$$

Source imposed in field 2

$$s_2$$

## 2 Reference solution

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### 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  $s_2$ ,  $s_1 = -6$ ,  $s_2 = -5 \text{ W/m}^3$ .

### 2.2 Results of reference

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

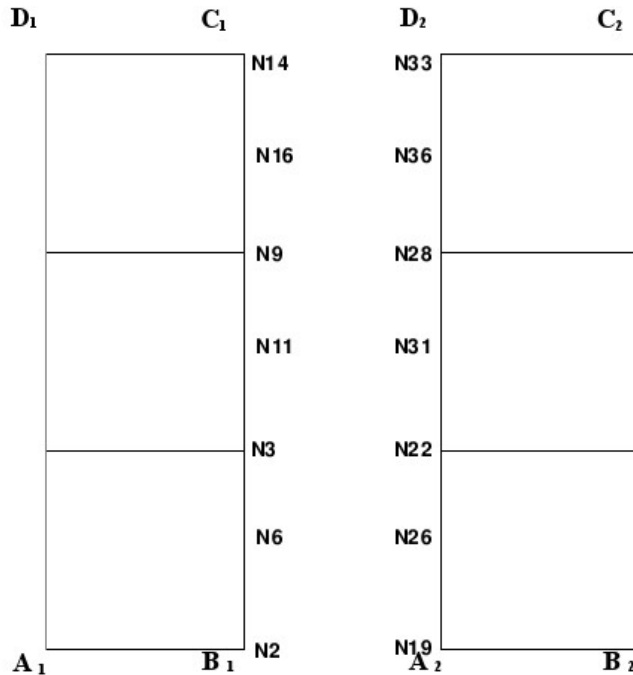
### 2.3 Uncertainty on the solution

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  $A_1$

Temperature imposed in  $B_2$

Normal flow imposed on the wall  $B_2C_2$

Normal flow imposed on the plans  $C_1D_1$  and  $C_2D_2$

Source imposed in field 1

Source imposed in field 2

$$T = 0. \text{ } ^\circ\text{C}$$

$$T = 4.5 \text{ } ^\circ\text{C}$$

$$\varphi = 3. \text{W/m}^2$$

$$\varphi = 6. \text{W/m}^2$$

$$s_1$$

$$s_2$$

### 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 <sub>1</sub> )	10.00
node N19 ( A <sub>2</sub> )	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 <sub>2</sub> )	11.00

## 3.5 Remarks

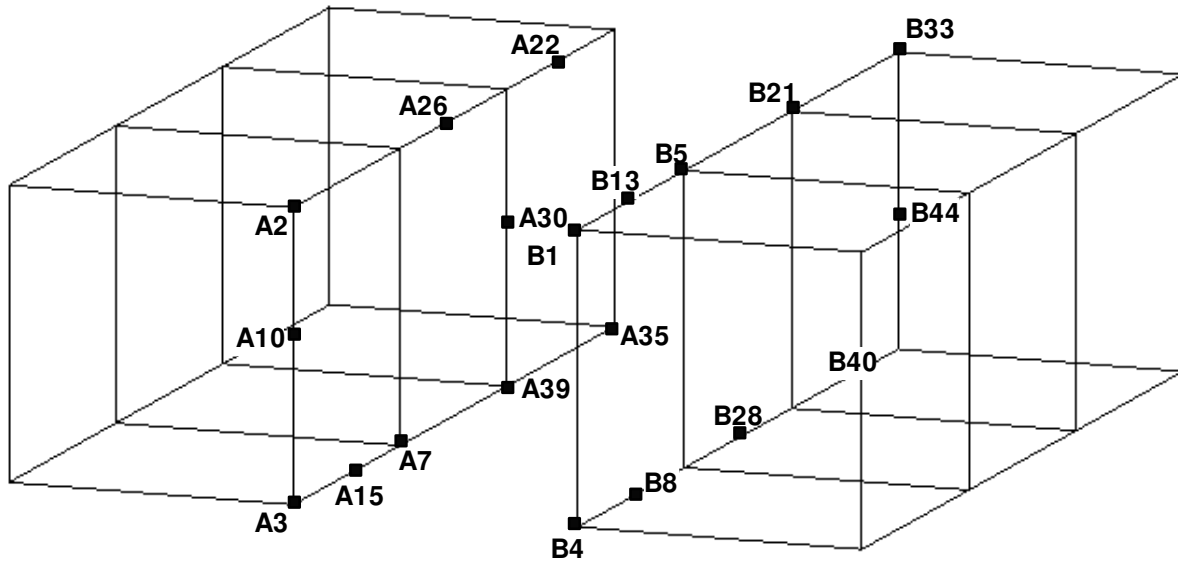
The functions of form of element QUAD8 being of order 2, it is natural to obtain the reference solution which is expressed in the form of a polynomial of order 2.

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 $A_2$ ( $B_1$ )	1.00
node $A_3$ ( $F_1$ )	2.00
node $A_7$	3.00
node $A_{10}$	1.25
node $A_{15}$	2.25
node $A_{22}$	5.00
node $A_{26}$	3.25
node $A_{30}$	5.25
node $A_{35}$ ( $G_1$ )	11.00
node $A_{39}$	8.25
node $B_1$ ( $A_2$ )	2.00
node $B_4$ ( $E_2$ )	3.00
node $B_5$	3.00
node $B_8$	4.00

node <i>B13</i>	2.25
node <i>B21</i>	6.00
node <i>B28</i>	5.25
node <i>B33</i> ( $D_2$ )	11.00
node <i>B40</i>	9.25
node <i>B44</i>	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  $B_1C_1$  identical to flow entering through the wall  $A_2D_2$

Temperature imposed in  $A_1$

Temperature imposed in  $B_2$

Normal flow imposed on the wall  $B_2C_2$

Normal flow imposed on the plans  $C_1D_1$  and  $C_2D_2$

Source imposed in field 1

Source imposed in field 2

$$T = 0. \text{ } ^\circ\text{C}$$

$$T = 4.5 \text{ } ^\circ\text{C}$$

$$\varphi = 3. \text{W/m}^2$$

$$\varphi = 6. \text{W/m}^2$$

$$s_1$$

$$s_2$$

### 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

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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`.