

## TTLP302 - Heat transfer in a Plan field with geometrical singularity

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### Summary:

This test is resulting from the validation independent of version 3 in linear transitory thermics.

It is about a problem 2D plan represented by two modelings, one planes, the other voluminal one.

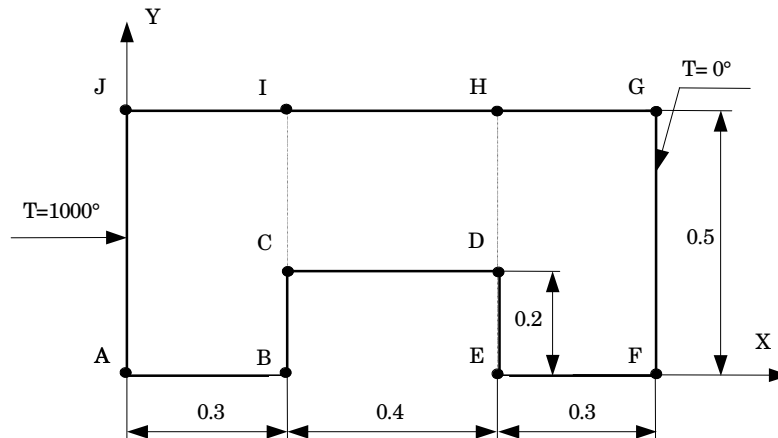
The features tested are the following ones:

- thermal element plan,
- voluminal thermal element,
- transitory algorithm of thermics,
- geometrical singularity,
- limiting conditions: imposed temperature.

The interest of the test, besides the fact that it is an industrial case, lies in the taking into account of a geometrical singularity in transitory thermal analysis.

## 1 Problem of reference

### 1.1 Geometry



### 1.2 Properties of material

$\lambda = 1. W/m^{\circ}C$  Thermal conductivity  
 $\rho C_p = 1. J/m^3^{\circ}C$  Voluminal heat

### 1.3 Boundary conditions and loadings

- $[AJ]$  imposed temperature  $T = 1000^{\circ}C$ ,
- $[FG]$  imposed temperature  $T = 0^{\circ}C$ ,
- others with dimensions  $\varphi = 0$ .

### 1.4 Initial conditions

$$T(x, y, 0) = \operatorname{erfc}\left(\frac{x}{2\sqrt{t}}\right) \quad \text{for } t = 0.0005 \text{ s}$$

## 2 Reference solution

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### 2.1 Method of calculating used for the reference solution

The reference solution is a digital solution obtained by the finite element method [bib2] quoted in the reference [bib1]. This solution is based on a network of 168 square elements of 0.05m of dimensioned, with 200 pas de time ( $\Delta t = 0.0005 s$ ).

### 2.2 Results of reference

Temperature at the points  $BCDEH$  and  $I$  at the moment  $t = 0.1s$

### 2.3 Uncertainty on the solution

Unknown factor.

### 2.4 Bibliographical references

- J.C. Bruch Jr., G. Zyrolowski, 'Transient two-dimensional heat conduction problems solved by the finite element method', *Int. J. num. Meth. Engng*, flight 8, n°3, pp 481-494, 1974.
- G.E. Beautiful, "with method for treating boundary singularities in time-dependent problems" TR/8, Dept. of Math., Brunel Univ. Uxbridge, Middlesex, 19 pp., 1972.

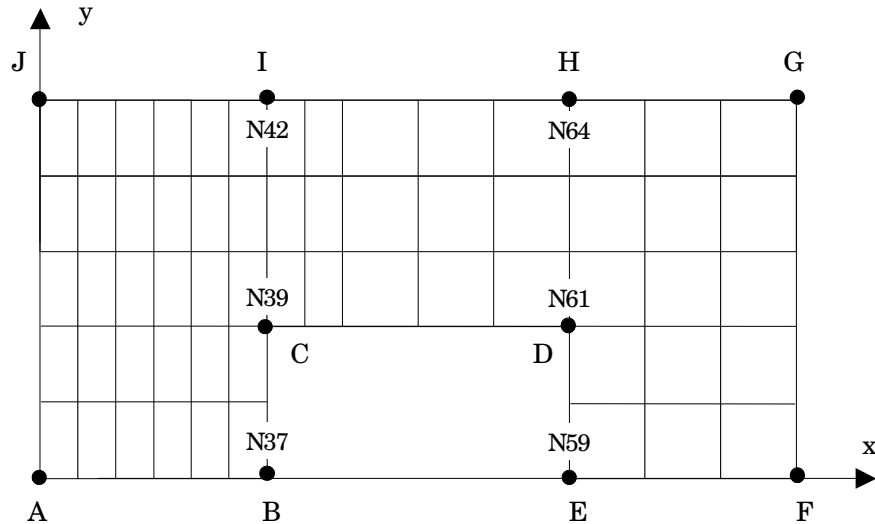
## 3 Modeling A

### 3.1 Characteristics of modeling

PLAN (QUAD4)

Conditions limites:

- coté AJ:  $T = 1000^{\circ}\text{C}$
- coté FG:  $T = 0^{\circ}\text{C}$
- cotés AB, BC, CD,  
DE, EF, GJ  $\phi = 0$



### 3.2 Characteristics of the grid

Many nodes: 82  
Many meshes and types: 60 QUAD4

### 3.3 Remarks

The discretization in step of time is the following one:

10 pas	for $[0., 1.D-4]$	that is to say $\Delta t = 1.D-5$
9 pas	for $[1.D-4, 1.D-3]$	that is to say $\Delta t = 1.D-4$
9 pas	for $[1.D-3, 1.D-2]$	that is to say $\Delta t = 1.D-3$
9 pas	for $[1.D-2, 1.D-1]$	that is to say $\Delta t = 1.D-2$

### 3.4 Sizes tested and results

Identification	Type of Reference	Reference	Tolerance
Temperature ( $^{\circ}\text{C}$ )			
$t = 0.1 \text{ s}$			
Points			
B (N37)	SOURCE_EXTERNE	787.	2%
C (N39)	SOURCE_EXTERNE	634.	2%
D (N61)	SOURCE_EXTERNE	86.	2%
E (N59)	SOURCE_EXTERNE	28.	2%
H (N64)	SOURCE_EXTERNE	119.	2%

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# Code\_Aster

Version  
default

Titre : TTLP302 - Transfert thermique dans un domaine Plan[...]  
Responsable : HAELEWYN Jessica

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$I(N42)$	SOURCE_EXTERNE	538.	2%
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## 4 Summary of the results

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Modeling carried out (PLAN with meshes QUAD4) give satisfactory results. The maximum change is of  $-0.73\%$  , and it is located on the smallest value of reference.

The taking into account of the initial condition of type  $\operatorname{erfc}\left(\frac{x}{2\sqrt{t}}\right)$  was carried out correctly. It required the use of the order CREA\_CHAMP allowing to define an initial field of temperature of each node of the model.