

## TPLP302 - Rectangular plate with imposed temperature

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### Summarized:

This test is resulting from the validation independent of version 3 in linear steady thermal.

It is about a problem 2D plane represented by a modelization shell.

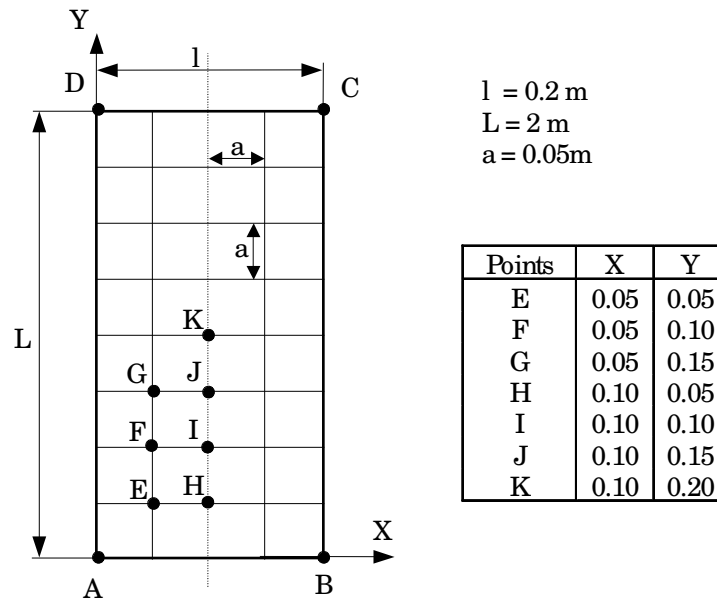
The features tested are the following ones:

- thermal element shell,
- limiting conditions: imposed temperature.

The results are compared with an analytical solution.

## 1 Problem of reference

### 1.1 Geometry



### 1.2 Properties of the thermal

$\lambda = 1 \text{ W/m}^\circ\text{C}$  material Conductivity

### 1.3 Boundary conditions and loadings

- imposed Temperature:
  - dimensioned  $[BC]$  and  $[AD]$   $T = 0^\circ\text{C}$  ,
  - dimensioned  $[AB]$   $T = 100^\circ\text{C}$  .
- Imposed flux:
  - dimensioned  $[CD]$   $\varphi = 0$

### 1.4 Initial conditions

Without object.

## 2 Reference solution

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

$$T(x, y) = \frac{4T_p}{\pi} \sum_{n=0}^{\infty} \frac{e^{[-(2n+1)\pi y/l]}}{2n+1} \cdot \sin\left[\frac{(2n+1)\pi x}{l}\right]$$

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ere

$x$  : X-coordinate  
 $y$  : Y-coordinate  
 $T_p$  : temperature imposed on with dimensions [AB]  
 $n = 0, 1, 2, 3, \dots$

the values of reference are obtained with  $n = 1000$

### 2.2 Results of reference

Temperature to the points  $E, F, G, H, I, J, K$

### 2.3 Uncertainty on the analytical

solution Solution.

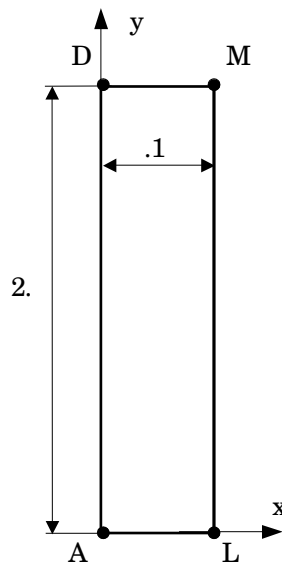
### 2.4 References

- [1] J.R. Welty, E.C. Wicks, R.E. Wilson, "Fundamentals of momentum heat and farmhouse transfer", third edition, John Wiley & Sounds, 1983.

### 3 Modelization A

#### 3.1 Characteristic of modelization

COQUE (TRIA6)



Conditions limites:

- coté AL  $T = 100^{\circ}\text{C}$
- coté AD  $T = 0^{\circ}\text{C}$
- coté LM  $\varphi = 0$
- coté DM  $\varphi = 0$

Points	X	Y	Noeuds
E	0.05	0.05	N21
F	0.05	0.10	N39
G	0.05	0.15	N57
H	0.10	0.05	N23
I	0.10	0.10	N41
J	0.10	0.15	N59
K	0.10	0.20	N77

Découpage:

- 4 éléments suivant x
- 40 éléments suivant y

#### 3.2 Characteristic of the mesh

Many nodes: 729  
Number of meshes and types: 320 TRIA6

#### 3.3 Remarks

the limiting conditions,  $T = 100^{\circ}\text{C}$  on  $AB$ , et sur  $T = 0^{\circ}\text{C}$   $AD$ , are incompatible at point A. Code\_Aster applies a "law of overload" which, in this case, consists in taking into account the last condition limits entered. The order of assignment of the imposed temperatures thus has a great influence on the got results.

In the treated case, the temperature assigned to the point  $A$  is of  $0^{\circ}\text{C}$ .

#### 3.4 Quantities tested and results

Identification	Reference	Aster	difference	tolerance
Temperature ( $^{\circ}\text{C}$ )				
N21 (surface_supérieure)	43.496	43.499	0.007	1%
N21 (surface_moyenne)	43.496	43.499	0.007	1%
N21 (surface_inférieure)	43.496	43.499	0.007	1%
N39 (surface_supérieure)	18.978	18.957	-0.112	1%
N39 (surface_moyenne)	18.978	18.957	-0.112	1%
N39 (surface_inférieure)	18.978	18.957	-0.112	1%
N57 (surface_supérieure)	8.559	8.554	-0.057	1%

N57 (surface_moyenne)	8.559	8.554	-0.057	1%
N57 (surface_inférieure)	8.559	8.554	-0.057	1%
N23 (surface_supérieure)	54.467	54.514	0.087	1%
N23 (surface_moyenne)	54.467	54.514	0.087	1%
N23 (surface_inférieure)	54.467	54.514	0.087	1%
N41 (surface_supérieure)	26.096	26.096	-0.001	1%
N41 (surface_moyenne)	26.096	26.096	-0.001	1%
N41 (surface_inférieure)	26.096	26.096	-0.001	1%
N59 (surface_supérieure)	12.032	12.025	-0.061	1%
N59 (surface_moyenne)	12.032	12.025	-0.061	1%
N59 (surface_inférieure)	12.032	12.025	-0.061	1%
N77 (surface_supérieure)	5.499	5.496	-0.063	1%
N77 (surface_moyenne)	5.499	5.496	-0.063	1%
N77 (surface_inférieure)	5.499	5.496	-0.063	1%

## 4 Summary of results

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The modelization `COQUE` with meshes `TRIA6` gives very satisfactory results, the maximum change obtained is of 0.11%. The interest of this test is of:

- to test meshes the `TRIA6` in `COQUE`,
- to compare the results compared to an analytical solution.