TPLP302 - Rectangular plate with imposed temperature

Summary:

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

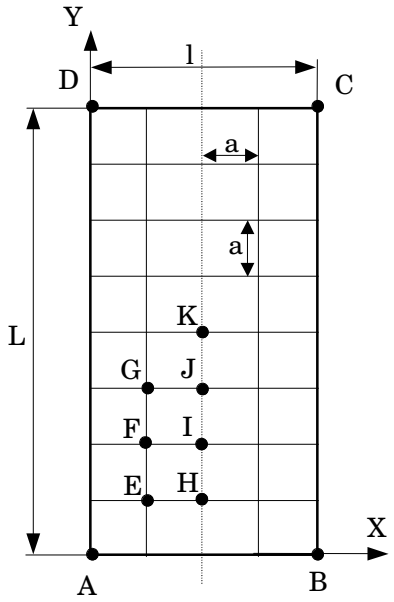
It is about a problem 2D plan represented by a modeling hull.

The features tested are the following ones:
- thermal element hull,
- limiting conditions: imposed temperature.

The results are compared with an analytical solution.

1 Problem of reference

1.1 Geometry



l = 0.2 m
L = 2 m
a = 0.05m

Points	X	Y
E	0.05	0.05
F	0.05	0.10
G	0.05	0.15
H	0.10	0.05
I	0.10	0.10
J	0.10	0.15
K	0.10	0.20

1.2 Properties of material

$\lambda = 1\, W/m°C$ Thermal conductivity

1.3 Boundary conditions and loadings

- Imposed temperature:
  - dimensioned $[BC]$ and $[AD]$ $T = 0°C$,
  - dimensioned $[AB]$ $T = 100°C$.
- Imposed flow:
  - dimensioned $[CD]$ $\varphi = 0$

1.4 Initial conditions

Without object.

2 Reference solution

2.1 Method of calculating used for the reference solution

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

where
x : X-coordinate
y : ordinate
T_p : temperature imposed on with dimensions one $[AB]$
$n=$ $0,1,2,3,...$

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

2.2 Results of reference

Temperature at the points E, F, G, H, I, J, K

2.3 Uncertainty on the solution

Analytical solution.

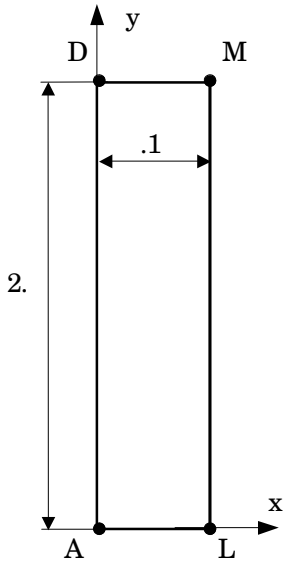
2.4 References

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

3 Modeling A

3.1 Characteristics of modeling

HULL (TRIA6)



Conditions limites:

- coté AL T = 100°C
- coté AD T = 0°C
- coté LM ϕ = 0
- coté DM ϕ = 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 Characteristics of the grid

Many nodes: 729
Many meshs and types: 320 TRIA6

3.3 Remarks

Limiting conditions, $T=100°C$ on AB, and $T=0°C$ on AD, are incompatible at point A. *Code_Aster* bracket 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 $0°C$.

3.4 Sizes tested and results

Identification	Reference	*Aster*	difference	tolerance
Temperature $(°C)$				
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 the results

Modeling HULL with meshs TRIA6 gives very satisfactory results, the maximum change obtained is of 0.11%. The interest of this test is of:

- to test meshs TRIA6 in HULL,
- to compare the results compared to an analytical solution.