

## TPLV304 - Distribution of the temperature in a bar of square section

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### Summary:

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

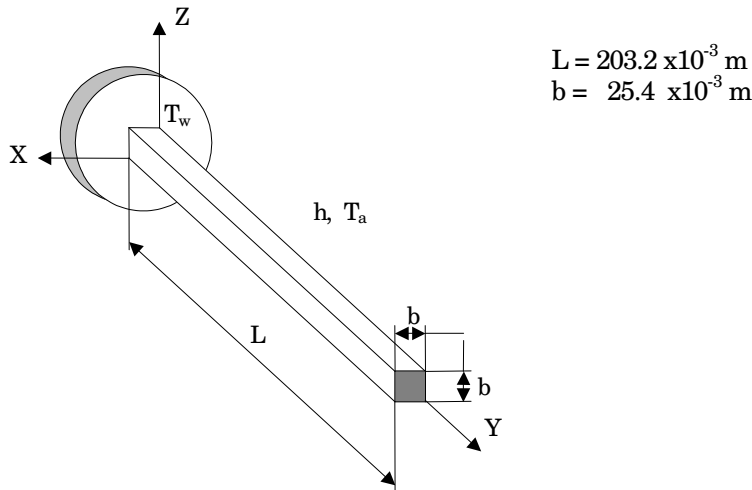
It aims to validate the voluminal thermal elements under conditions of convection and imposed temperature.

The reference solution is based on an analytical approach.

## 1 Problem of reference

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### 1.1 Geometry



### 1.2 Properties of material

$\lambda = 43.2675 \text{ W/m} \cdot ^\circ\text{C}$  Thermal conductivity

### 1.3 Boundary conditions and loadings

- temperature imposed on the face  $y=0$   $T_w = 37.78^\circ\text{C}$ ,
- $\varphi = 0$  on the face  $y=L$ ,
- convection on the others faces:
  - $h = 5.678 \text{ W/m}^2 \cdot ^\circ\text{C}$ ,
  - $T_a = -17.780^\circ\text{C}$ .

### 1.4 Initial conditions

Without object.

## 2 Reference solution

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

The original reference solution given in the book [bib1] is based on an analytical approach. This reference is quoted in the handbook of checking of ANSYS [bib2]

### 2.2 Results of reference

Temperature on the face  $y=l$

### 2.3 Uncertainty on the solution

Unknown factor, it was not possible to get the original reference (delivers old, more published).

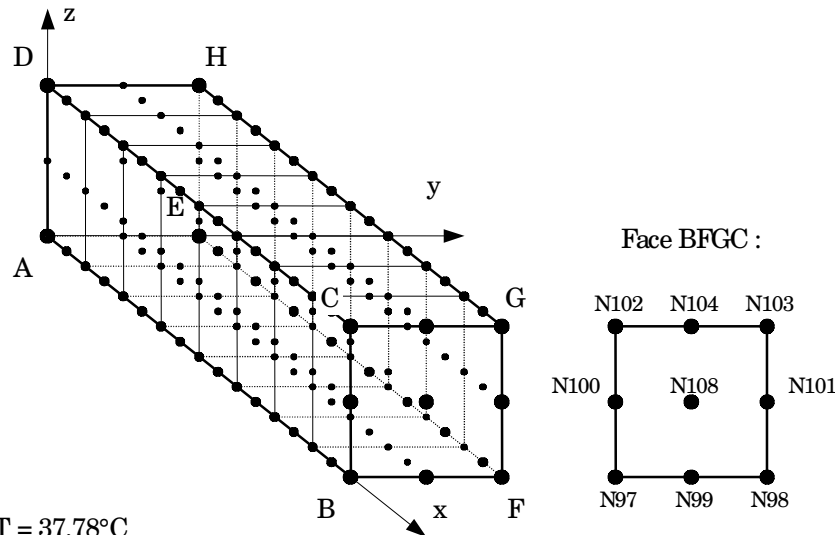
### 2.4 Bibliographical references

- [1] ANSYS: "Checking manual", 1<sup>st</sup> edition, June 1.1976
- [2] Kreith, F., "Principles of heat transfer", International Textbook Co., Scranton, Pennsylvania, 2nd Printing, 1959.

## 3 Modeling A

### 3.1 Characteristics of modeling

3D (HEXA27)



Conditions limites:

- face AEHD  $T = 37.78^{\circ}\text{C}$
- face BFGC  $\phi = 0$
- faces ABCD, ABFE, EFGH, DCGH  $h = 5.678 \text{ W/m}^2\text{C}$   
 $T_{\text{ext}} = -17.78^{\circ}\text{C}$

### 3.2 Characteristics of the grid

Many nodes: 153  
Many meshes and types: 8 HEXA27 (and 32 QUAD9)

### 3.3 Sizes tested and results

Identification	Reference	Aster	Relative variation (%)		Absolute deviation ( $^{\circ}\text{C}$ )		
			difference	tolerance	difference	tolerance	
Temperature ( $^{\circ}\text{C}$ )							
at the end of the bar							
$Y = L$	20,329						
B	N97	20,329	20,295	0,166	1%	0.0338	0.5
medium BF	N99	20,329	20,327	0,010	1%	0.0021	0.5
F	N98	20,329	20,295	0,166	1%	0.0338	0.5
medium FG	N101	20,329	20,327	0,010	1%	0.0021	0.5
G	N103	20,329	20,295	0,166	1%	0.0338	0.5
medium GC	N104	20,329	20,327	0,010	1%	0.0021	0.5
C	N102	20,329	20,295	0,166	1%	0.0338	0.5
medium CB	N100	20,329	20,327	0,010	1%	0.0021	0.5
medium of the face	N108	20,329	20,359	0,146	1%	0.0297	0.5

### 3.4 Remarks

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Voluminal heat  $\rho C_p$  does not intervene in this test, but must be declared for *Code\_Aster*. One takes  $\rho C_p = 1.0 \text{ J/m}^3 \text{ }^\circ\text{C}$ .

The limiting condition  $\varphi = 0$ , is implicit on the free edges.

The small differences which remain correspond to a variation in temperature in the section observed. What is in conformity with the modelled physical phenomenon.

## 4 Summary of the results

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The got results are very satisfactory, the maximum change is of  $-0.166\%$ . The principal interest of this test is to check mesh HEXA27.