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

Summary:

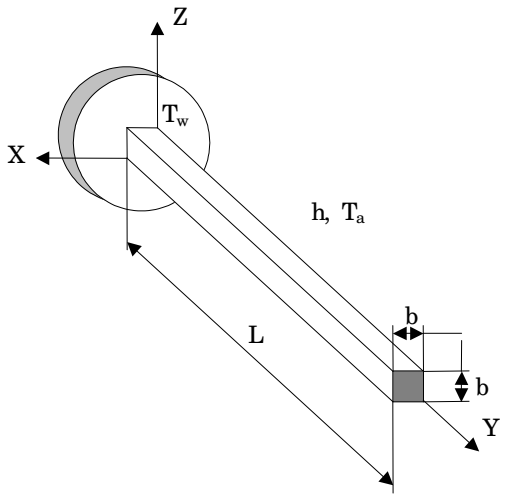
This test is resulting from the validation independent of version 3 in linear stationary thermics.

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

1.1 Geometry



L = 203.2 x10^{-3} m
b = 25.4 x10^{-3} m

1.2 Properties of material

$\lambda = 43.2675\, W/m.°C$ Thermal conductivity

1.3 Boundary conditions and loadings

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

1.4 Initial conditions

Without object.

2 Reference solution

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

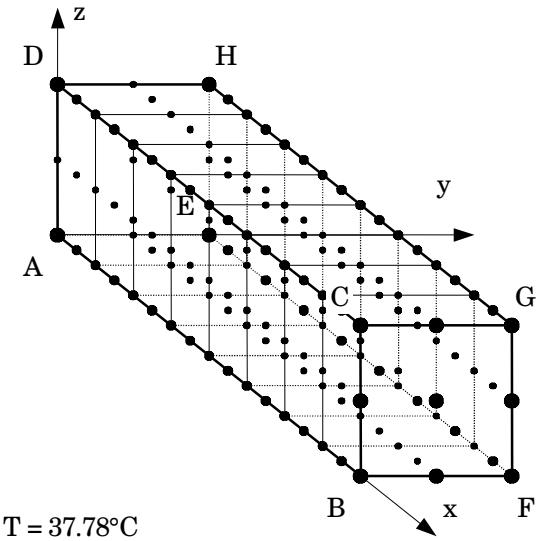
[1] ANSYS: “Checking manual”, 1 St edition, June 1.1976

[2] Kreith, F., “Principles of heat transfer”, International Textbook Co., Scranton, Pennsylvania, 2nd Printing, 1959.

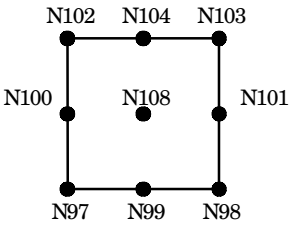
3 Modeling A

3.1 Characteristics of modeling

3D (HEXA27)



Face BFGC :



Conditions limites:

- face AEHD T = 37.78°C
- face BFGC $\phi = 0$
- faces ABCD, ABFE, EFGH, DCGH h = 5.678 W/m²°C, T_{ext} = -17.78 °C

3.2 Characteristics of the grid

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

3.3 Sizes tested and results

Identification		Reference	*Aster*	Relative variation (%)		Absolute deviation (°C)	
				difference	tolerance	difference	tolerance
Temperature $(°C)$							
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

Voluminal heat ρC_P does not intervene in this test, but must be declared for *Code_Aster*. One takes $\rho C_P = 1.0 J/m^3 °C$.

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

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