TPLA301 - Distribution of temperature in a cylinder runs

Summary:

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

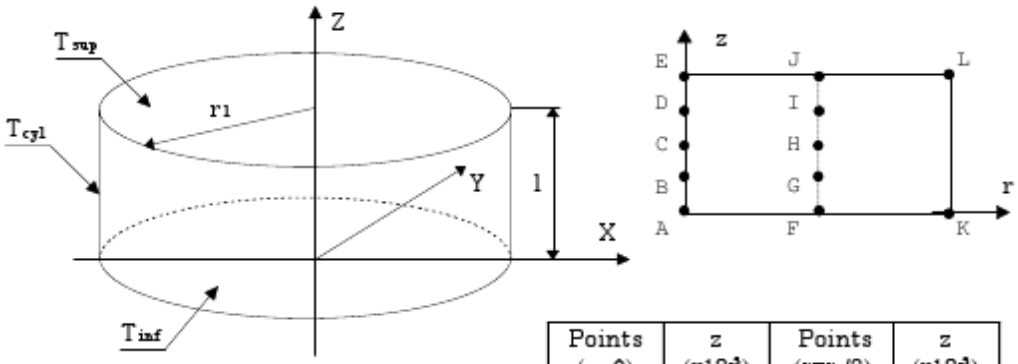
The axisymmetric problem 2D aims to validate the axisymmetric thermal elements under temperature imposed in the case of a cylinder court on radial and axial behavior.

It comprises only one modeling (axisymmetric).

The results are compared with a solution based on a graphic estimate.

1 Problem of reference

1.1 Geometry



$r_1 = l = 0.1524$ m

Points (r=0)	z (x10⁻³)	Points (r=r1/2)	z (x10⁻³)
A	0.0	F	0.0
B	38.1	G	38.1
C	76.2	H	76.2
D	114.3	I	114.3
E	152.4	J	152.4

1.2 Properties of material

$\lambda = 1.7307\, W/m°C$ Thermal conductivity

1.3 Boundary conditions and loadings

Imposed temperatures:

- $T_{inf} = T_{cyl} = -17.778°C$,
- $T_{\sup} = 4.444°C$

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 a graphic estimate. This reference is quoted in the handbook of checking of ANSYS [bib2]

2.2 Results of reference

Temperature at the points $A\,B\,C\,D\,E\,F\,G\,H\,I\,J$

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

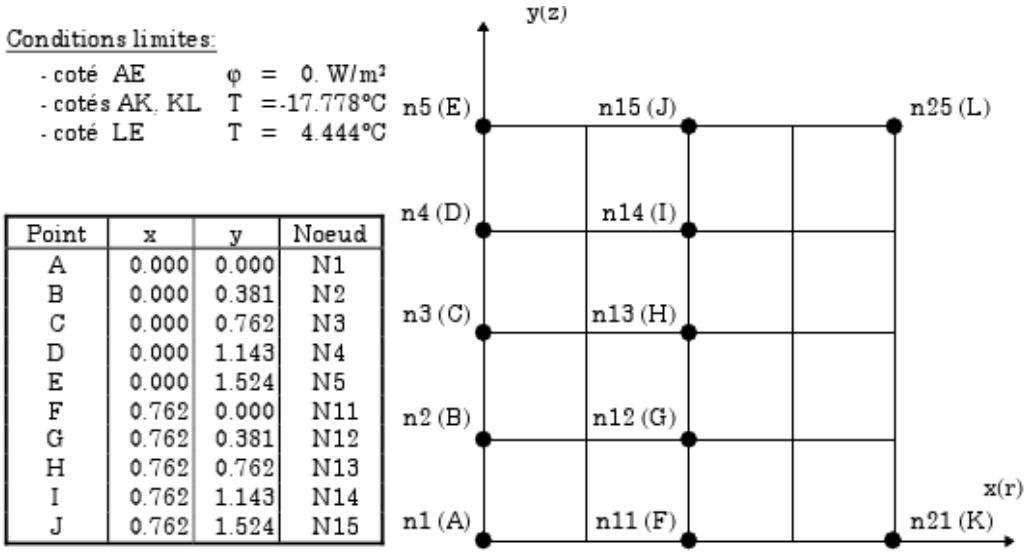
[1] Schneider, P.J., “Conduction Heat Transfer”, Addison-Wesley Publishing Co., Inc. Reading, Farmhouse., 2nd Printing, 1957.

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

3 Modeling A

3.1 Characteristics of modeling

AXIS (QUAD4)



Point	x	y	Noeud
A	0.000	0.000	N1
B	0.000	0.381	N2
C	0.000	0.762	N3
D	0.000	1.143	N4
E	0.000	1.524	N5
F	0.762	0.000	N11
G	0.762	0.381	N12
H	0.762	0.762	N13
I	0.762	1.143	N14
J	0.762	1.524	N15

3.2 Characteristics of the grid

Many nodes: 25
Many meshs and types: 16 QUAD4

3.3 Remarks

Voluminal heat ρC_P does not intervene in this test, but must obligatorily be declared. One takes $\rho C_P = 2.0 J/m^3 °C$.

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

Limiting conditions, $T = -17.778 °C$ on KL, and $T = 4.444 °C$ on, are incompatible at the point L (node n25).

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 case treated, the temperature on the higher face (IT) is affected after that on the blank of cylinder (KL).

3.4 Sizes tested and results

Identification	Reference	*Aster* Front KL	% difference Front KL	NISA
Temperature $(°C)$				
Nodes				
n1 T (A)	-17,778	-17,778	0.00%*	– 17,778
N2 T (B)	-14,000	-13.79	-1.50%	– 13,953
n3 T (C)	-9,111	-8,908	-2.27%	– 9,151
n4 T (D)	-2,889	-2,713	**-6.10%**	– 2,892
n5 T (E)	4,444	4,444	0.00%*	4,444
n11 T (F)	-17,778	-17,778	0.00%*	– 17,778
n12 T (G)	-14,889	-14,999	0.74%	– 15,179
n13 T (H)	- 10,667	-11,005	3.16%	– 11,499
n14 T (I)	-4,444	-4,412	**-0.72%**	– 4,854
n15 T (J)	4,444	4,444	0.00%*	4,444

(*: Imposed temperature)

4 Summary of the results

Modeling gives results whose value (on 10) exceeds the tolerance fixed initially (5%). The maximum change obtained is of -6.10%, it is located on the smallest value of reference.

In this test, *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.

Calculations were carried out in $°C$. Determination of the variation, by considering the temperatures in $°F$, a maximum value very different from that obtained gives in $°C$.

A calculation carried out with software NISA gives identical results has those of Code_Aster (checked if the temperature imposed on the point L is of $4.44°C$).

The quality of the results could be improved by carrying out a finer grid, the problem of the overload would be always present, but the zone of influence of the temperature imposed on the point L would be weaker. The results are regarded as acceptable taking into account modeling carried out (grid and system of unit, law of overload).