TPLA301 - Distribution of temperature in a short Summarized

cylinder:

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

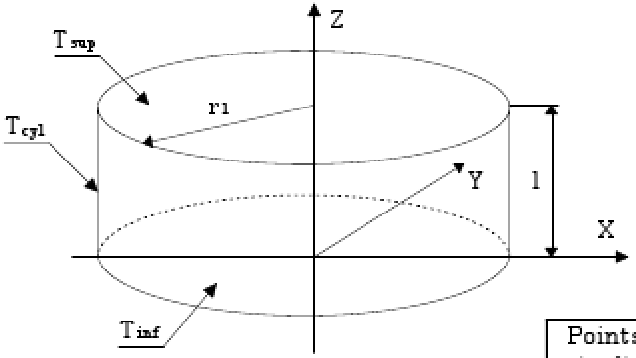
The problem 2D axisymmetric aims to validate the axisymmetric thermal elements under temperature imposed in the case of a cylinder court on radial and axial behavior.

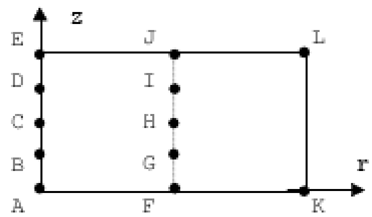
It comprises only one modelization (axisymmetric).

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 ($r=r_1/2$)	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 the thermal

$\lambda = 1.7307\, W/m°C$ material 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 to the points $A\ B\ C\ D\ E\ F\ G\ H\ I\ J$

2.3 Uncertainty on the Unknown

solution, 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 Modelization A

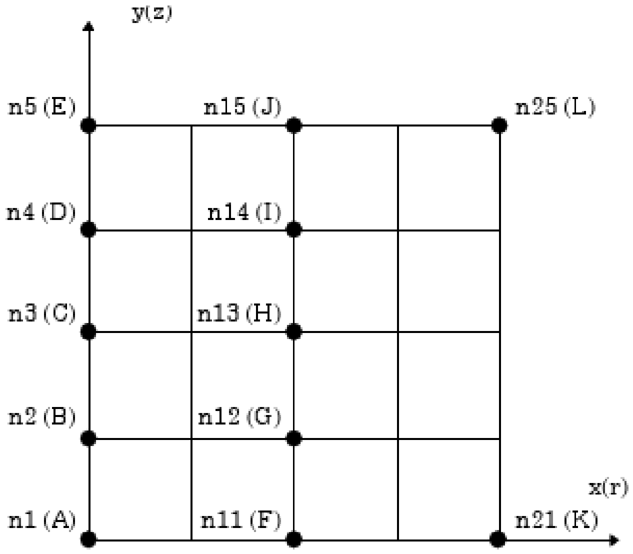
3.1 Characteristic of modelization

AXIS (QUAD4)

Conditions limites:

- coté AE $\varphi = 0.\ W/m^2$
- cotés AK, KL $T = -17.778°C$
- coté LE $T = 4.444°C$

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 Characteristic of the mesh

Many nodes: 25
Number of meshes and types: 16 QUAD4

3.3 Remarks

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

The implicit condition $\varphi = 0.$ limiteest on free edges.

The limiting conditions, $T = -17.778 \circ C$ on KL, and $T = 4.444 \circ C$ LE, are incompatible at the point L (node n25).

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

3.4 Quantities tested and results

Identification	Reference	*Aster* KL before	% difference KL before	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

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

In this test, *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.

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

A computation 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 mesh, 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 the modelization carried out (mesh and system of unit, model of overload).