TPLA04 - Release of power in a Summarized hollow roll

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

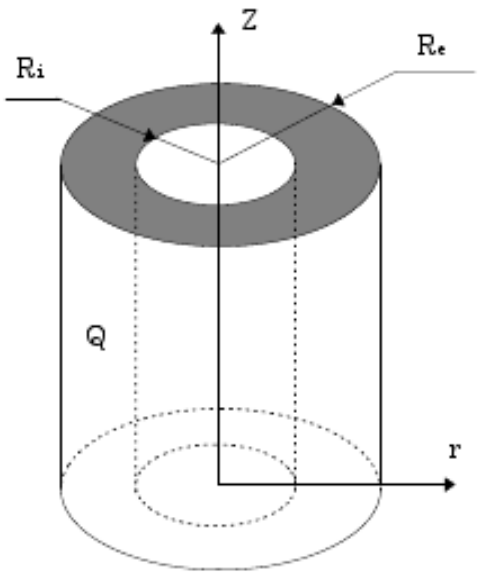
It comprises a modelization 2D axisymmetric which tests the axisymmetric elements in thermal, the boundary conditions in temperature imposed and the boundary conditions of type heat source.

This test aims to validate the taking into account of the heat source by comparing the results got with those provided by VPCS.

1 Problem of reference

1.1 Geometry

interior Radius	$R_i = 1\text{m}$
Radius external	$R_e = 2\text{m}$
Length	l



1.2 Properties of the thermal

$\lambda = 1.0\, W/m°C$ material Conductivity

1.3 Boundary conditions and loadings

- imposed Temperatures:
- Interior surface: $T_i = T(r = R_i) = 20°$
  External surface: $T_e = T(r = R_e) = 20°$
- Uniform released power $Q = 100\text{W}/m^3$

1.4 Initial conditions

Without object.

2 Reference solution

2.1 Method of calculating used for the reference solution

the reference solution is that given in file TPLA04/89 of guide VPCS.

- Temperature according to r :

$$T(r)=T_i+\frac{Q}{4\lambda}\left[(R_e^2-R_i^2)\frac{\ln(\frac{r}{R_i})}{\ln(\frac{R_e}{R_i})}-(r^2-R_i^2)\right]$$

- Density flux according to r :

$$\Phi(r)=-\lambda\frac{dT}{dr}=-\frac{Q}{4r}\left[\frac{(R_e^2-R_i^2)}{\ln(\frac{R_e}{R_i})}-2\mathrm{r}^2\right]$$

The cylinder is supposed infinitely long ($l \gg R_e$)

2.2 Results of reference

Temperature and density flux for $r=1.0\,,\,1.2\,\mathrm{et}\,1.5$

2.3 Uncertainty on the analytical

solution Solution.

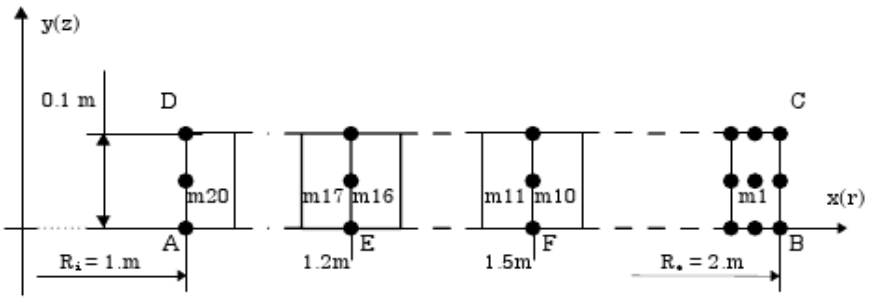
2.4 Bibliographical references

[1] Guides validation of the software packages of structural analysis. French company of the Mechanics, AFNOR 1990 ISBN 2-12-486611-7

3 Modelization A

3.1 Characteristic of modelization

AXIS (QUAD9)



Conditions limites:

- cotés AD, BC T = 20 °C
- tout Q = 100 W/m³
- cotés AB, CD φ = 0. W/m²

Point	r	z	Noeud
A	1.0	0.0	N1
D	1.0	0.1	N3
E	1.2	0.0	N25
F	1.5	0.0	N61
B	2.0	0.0	N121
C	2.0	0.1	N123

3.2 Characteristic of the mesh

Many nodes: 123
Number of meshes and types: 20 QUAD9

3.3 Remarks

voluminal heat ρC_P do 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 free edges.

3.4 Quantities tested and results

Identification	Reference	*Code_Aster*	% difference	tolerance
Temperature (°C)				
Node n1 (a: R = 1.0)	20.00	20.0000	0.000%*	1%
Node n25 (E: R = 1.2)	28.73	28.7276	0.008%	1%
Node n61 (F: R = 1.5)	32.62	32.6222	0.007%	1%
Density flux (W/m^2)				
Nets m20 n1 (R = 1.0)	-58.20	-58.1592	-0.070%	1%
Mesh m17 n25 (R = 1.2)	-30.17	-30.1412	-0.095%	1%
Mesh m16 n25 (R = 1.2)	-30.17	-30.1434	-0.088%	1%
Mesh m11 n61 (R = 1.5)	2.87	2.8791	0.316%	1%
Mesh m10 n61 (R = 1.5)	2.87	2.8782	0.285%	1%

4 Summary of the results

the got results are very satisfactory. The maximum change is of -0.008% in temperature and 0.316% out of flux.

This test made it possible meshes to test the taking into account of a source term within the QUAD9 with a modelization AXIS (AFFE_CHAR_THER associated with key word SOURCE).