TPLA07 - Hollow roll orthotropic

Abstract:

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

It is about a problem 2D axisymmetric represented by two modelizations, the first three-dimensional one, the second 2D axisymmetric.

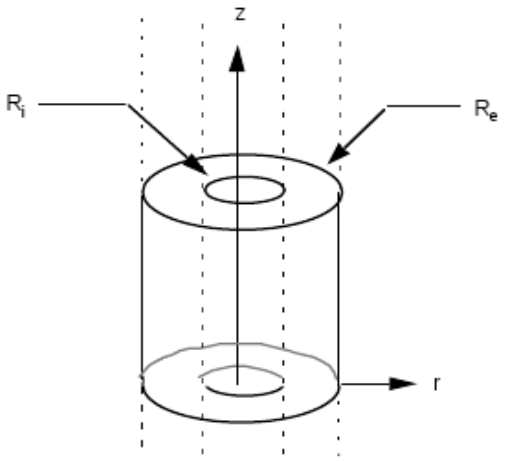
The interest of this case test is to test an orthotropic material subjected to various boundary conditions (imposed flux, convection, linear variation of the outside temperatures).

The results resulting from this case test are compared with those provided by VPCS.

1 Problem of reference

1.1 Geometry

interior Radius $R_i = 0.03\,m$
Radius external $R_e = 0.05\,m$
Height $l = 0.40\,m$



1.2 Properties of the thermal

$\lambda_t = 2.89\,W/m°C$ material conductivity along the thermal r
$\lambda_z = 40.0\,W/m°C$ axis conductivity along the circumferential z
λ axis: unspecified

1.3 Boundary conditions and loadings

- density flux $\varphi = -500\,W/m^2$ through surface $z = 0$ (outgoing flux),
- density flux $\varphi = +500\,W/m^2$ through surface $z = 0.4$ (entering flux),

- convection on interior surface: $h = 377.0\,W/m2°C$,
- convection on external surface: $h = 339.3\,W/m2°C$,

- linear variation of the outside temperatures:
  - on surface R_i : $T_i^e = 130°C$ in $z = 0$; $T_i^e = 135°C$ in $z = 0.4$ $(T_i^e = 130 + 12.5\,z)$
  - on surface R_e : $T_e^e = 20°C$ in $z = 0$; $T_e^e = 25°C$ in $z = 0.4$ $(T_e^e = 20 + 12.5\,z)$

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 TPLA07/89 of guide VPCS.

Temperature: $T(r,z)=-117.46\log r+12.5\,z-311.87$

2.2 Results of reference

- temperature in $r=0.03, 0.035, 0.04$ and 0.05 for $z=0., 0.2$ and 0.4,
- density flux on interior and external surface,
- density flux following the axis z.

2.3 Uncertainty on the analytical

solution Solution.

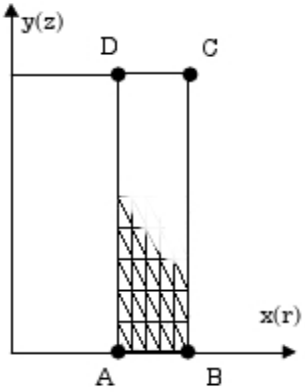
2.4 Bibliographical references

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

3 Modelization A

3.1 Characteristic of modelization

AXIS (TRIA6)



Boundary conditions:

Side AB : $\varphi = 500.\ W/m^2$

Side CD : $\varphi = -500.\ W/m^2$

Side DA : $h = 377.\ W/m^2 °C$
$T_i^e = 130. + 12.5\,z$

Side BC : $h = 339.3\ W/m^2 °C$
$T_e^e = 20. + 12.5\,z$

Cutting:

49 elements according to y

5 elements according to x

3.2 Characteristics of the mesh

Many nodes:	1089
Number of meshes and types:	490 TRIA6 (and 108 SEG3)

3.3 Remarks

voluminal heat ρC_P do 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 free edges.

3.4 Values tested

the values tested are the temperatures and the densities flux calculated with option FLUX_NOEU.

Identification	Coordinated		Temperature ($°C$)
	R	Z	Reference
N1	0.03	0.0	45.01
N5	0.034	0.0	54.8
N6	0.038	0.0	65.49
N7	0.042	0.0	77.24
N8	0.046	0.0	90.31
N2	0.05	0.0	105.01
N3	0.05	0.4	100.01
N57	0.046	0.4	85.31
N58	0.042	0.4	72.24
N59	0.038	0.4	60.49
N60	0.034	0.4	49.8
N4	0.03	0.4	40.01
N32	0.05	0.196	42.46
N33	0.05	0.204	42.56
N84	0.03	0.204	102.56
N85	0.03	0.196	102.46
N132	0.034	0.196	87.76
N133	0.034	0.204	87.86
N180	0.038	0.196	74.69
N181	0.038	0.204	74.8
N228	0.042	0.196	62.94
N229	0.042	0.204	63.04
N276	0.046	0.196	52.25
N277	0.046	0.204	52.35

Identification	Coordinated		Density of fluxformule φ_z (W/m^2)
	R	Z	reference
N1	0.03	0.0	-500
N5	0.034	0.0	-500
N6	0.038	0.0	-500
N7	0.042	0.0	-500
N8	0.046	0.0	-500
N2	0.05	0.0	-500
N3	0.05	0.4	-500
N57	0.046	0.4	-500
N58	0.042	0.4	-500
N59	0.038	0.4	-500
N60	0.034	0.4	-500
N4	0.03	0.4	-500
N32	0.05	0.196	-500
N33	0.05	0.204	-500
N84	0.03	0.204	-500
N85	0.03	0.196	-500
N132	0.034	0.196	-500
N133	0.034	0.204	-500
N180	0.038	0.196	-500
N181	0.038	0.204	-500
N228	0.042	0.196	-500
N229	0.042	0.204	-500
N276	0.046	0.196	-500
N277	0.046	0.204	-500

Identification	Coordinated		Density of fluxformule φ_{R_i} (W/m^2)
	R	Z	Reference
N1	0.03	0.0	11315.3
N5	0.034	0.0	9984.1
N6	0.038	0.0	8933.14
N7	0.042	0.0	8082.37
N8	0.046	0.0	7379.55
N2	0.05	0.0	6789.19
N3	0.05	0.4	6789.19
N57	0.046	0.4	7379.55
N58	0.042	0.4	8082.37
N59	0.038	0.4	8933.14
N60	0.034	0.4	9984.1
N4	0.03	0.4	11315.3
N32	0.05	0.196	6789.19
N33	0.05	0.204	6789.19
N84	0.03	0.204	11315.3
N85	0.03	0.196	11315.3
N132	0.034	0.196	9984.1
N133	0.034	0.204	9984.1
N180	0.038	0.196	8933.14
N181	0.038	0.204	8933.14
N228	0.042	0.196	8082.37
N229	0.042	0.204	8082.37
N276	0.046	0.196	7379.55
N277	0.046	0.204	7379.55

4 Summary of the results

the got results are satisfactory in temperature and of density flux, the maximum departures obtained are the following:

- 0.02% in temperature,
- 1.05% for flux along the axis z ,
- 0.33% for flux according to the radius.