TPLV06 - Release of power in a hollow sphere

Abstract:

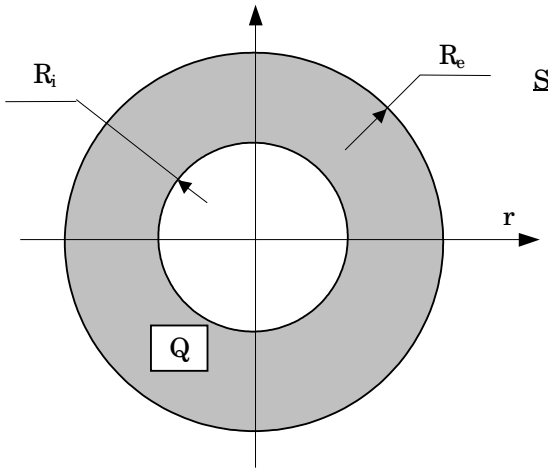
This test is resulting from the validation independent of version 3 in linear steady thermal.

It is about a three-dimensional problem which aims to validate the voluminal thermal element subjected to an imposed temperature and a heat source.

This case test understands a modelization 3D. The results are compared with an analytical solution (VPCS).

1 Problem of reference

1.1 Geometry



Sphère creuse:
- Rayon intérieur $R_i = 1$ m
- Rayon extérieur $R_e = 2$ m

1.2 Properties of the thermal

$\lambda = 1. W/m°C$ material Conductivity

1.3 Boundary conditions and loadings

- $T_i = T(r = R_i) = 20°C$
- $T_e = T(r = R_e) = 20°C$
- $Q = 100 W/m^3$.

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 TPLV06/89 of guide VPCS.

- Temperature according to r :

$$T = T_i + \frac{Q}{6\lambda}\left[\frac{(R_e^2 - R_i^2)\left[\frac{1}{R_i} - \frac{1}{r}\right]}{\left[\frac{1}{R_i} - \frac{1}{R_e}\right]} - (r^2 - R_i^2)\right]$$

- Density flux according to r :

$$\phi = -4\pi r^2 \lambda \frac{dT}{dr} = -\frac{2\pi Q}{3}\left[(R_e^2 - R_i^2)\left[\frac{1}{R_i} - \frac{1}{R_e}\right] - 2r^3\right]$$

2.2 Results of reference

Temperature in $r = 1.25$; 1.5 and $1.75\,m$

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

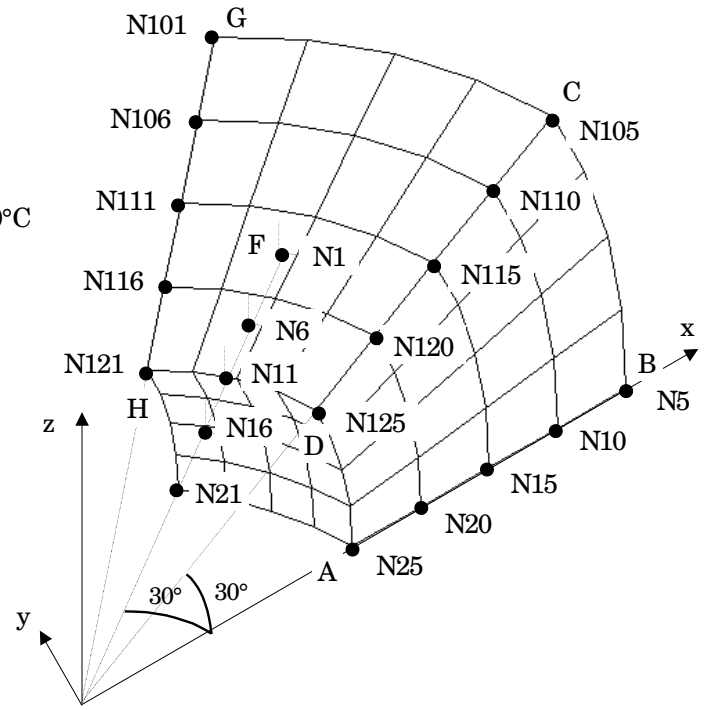
3 Modelization A

3.1 Characteristic of the modelization

3D (HEXA8)

Conditions limites:

- faces ABCD, EFGH, ABFE, DCGH φ = 0
- faces ADHE, BCGF T = 20°C



3.2 Characteristic of the mesh

Many nodes:	125
Number of meshes and types:	64 HEXA8

3.3 Quantities tested and results

Identification	Reference	*Aster*	% difference	tolerance
Temperature $(°C)$				
R = 1.25 (N16)	30.625	30.471	0.504	1%
R = 1.25 (N116)	30.625	30.471	0.504	1%
R = 1.25 (N20)	30.625	30.462	0.532	1%
R = 1.25 (N120)	30.625	30.462	0.532	1%
R = 1.50 (N11)	32.500	32.337	0.500	1%
R = 1.50 (N111)	32.500	32.337	0.500	1%
R = 1.50 (N15)	32.500	32.335	0.507	1%
R = 1.50 (N115)	32.500	32.335	0.507	1%
R = 1.75 (N6)	28.482	28.379	0.362	1%
R = 1.75 (N106)	28.482	28.379	0.362	1%
R = 1.75 (N10)	28.482	28.382	0.351	1%
R = 1.75 (N110)	28.482	28.382	0.351	1%

4 Summary of the results

the got results are satisfactory, the maximum change obtained is of 0.53%.

The modelization 3D used to model this sphere is correct.

The quality of the results could be still improved in:

- carrying out a finer mesh of the portion of sphere,
- choosing quadratic elements for better approximating the reference solution.