

TPLV06 - Release of power in a hollow sphere

Summary:

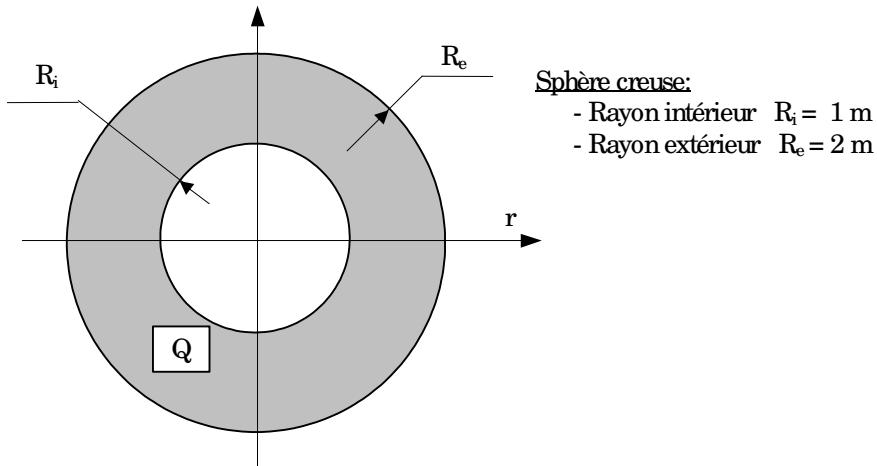
This test is resulting from the validation independent of version 3 in linear stationary thermics.

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

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

1 Problem of reference

1.1 Geometry



1.2 Properties of material

$\lambda = 1. W / m \cdot ^\circ C$ Thermal conductivity

1.3 Boundary conditions and loadings

- $T_i = T(r = R_i) = 20 \text{ } ^\circ C$,
- $T_e = T(r = R_e) = 20 \text{ } ^\circ C$,
- $Q = 100 W / m^3$.

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 card 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 solution

Analytical solution.

2.4 Bibliographical references

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

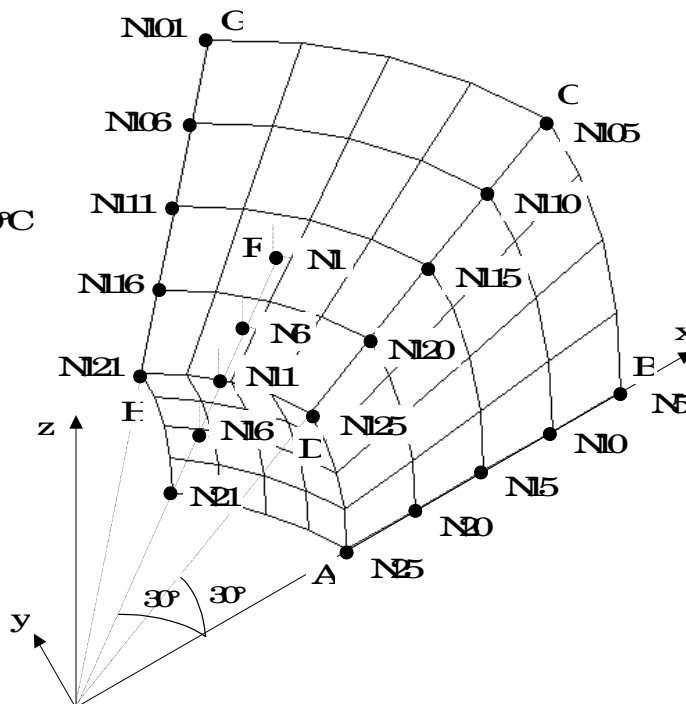
3 Modeling A

3.1 Characteristics of modeling

3D (HEXA8)

Conditions limites

- faces ABCD, EFGH
ABFE, DCGH $\phi = 0$
- faces ADHE, BCGF $T = 20^\circ\text{C}$



3.2 Characteristics of the grid

Many nodes: 125
Many meshes and types: 64 HEXA8

3.3 Sizes tested and results

Identification	Reference	Aster	% difference	tolerance
Temperature ($^\circ\text{C}$)				
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%.

Modeling 3D used to model this sphere is correct.

The quality of the results could be still improved in:

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