# TPLV06 - Release of power in a hollow sphere

**Summary:**

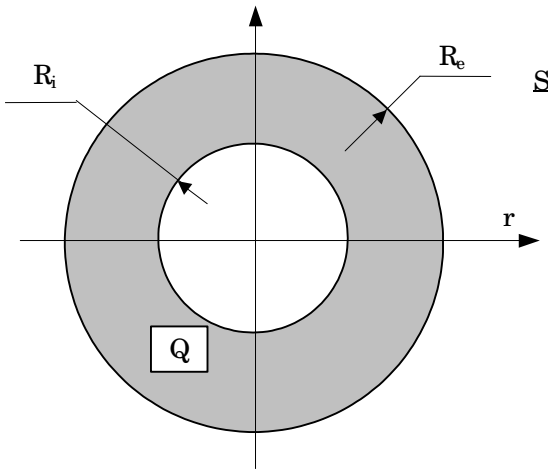
This test is resulting from the validation independent of version 3 in linear stationary thermics.

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




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

## 1.2 Properties of material

$\lambda = 1. W/m°C$ Thermal 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 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

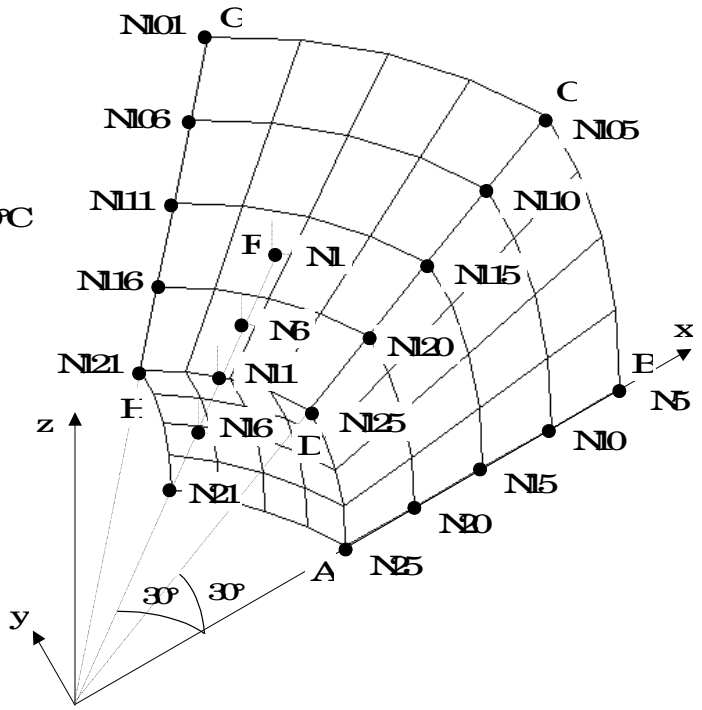
# 3 Modeling A

## 3.1 Characteristics of modeling

**3D (HEXA8)**

Conditions limites:

- faces ABCD, EFGH, ABFE, DCGH $\Phi = 0$
- faces ADHE, BCGF $T = 20°C$




## 3.2 Characteristics of the grid

| | |
|---|---|
| Many nodes: | 125 |
| Many meshs and types: | 64 HEXA8 |

## 3.3 Sizes 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%.

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.