

## TPLA01 - Infinite hollow roll in balance thermics

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### Summary:

Linear stationary thermics.

Axisymmetric model; 4 modelings.

Analytical solution.

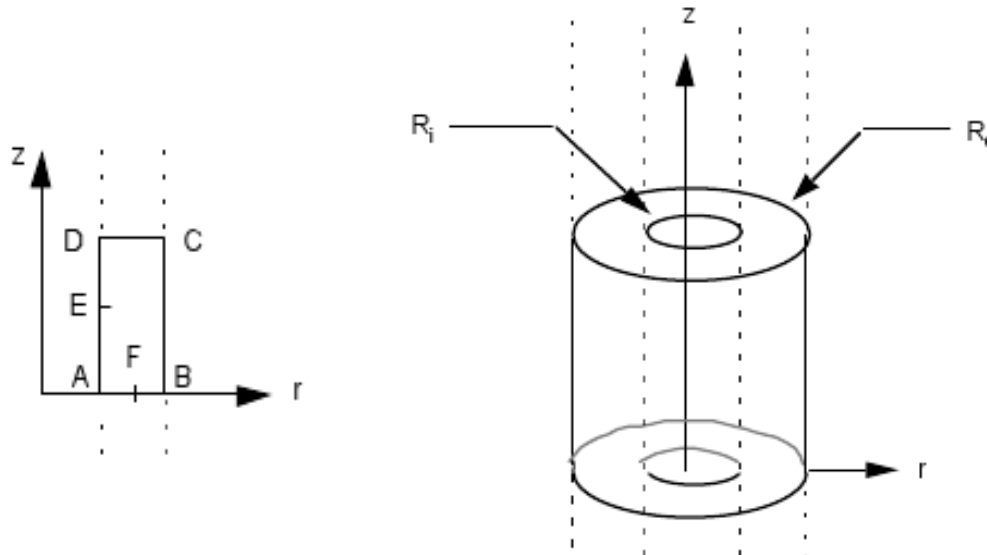
Interest of the test:

- **all** axisymmetric elements: triangles and quadrangles, linear and quadratic,
- axisymmetric element of hull: quadratic segments
- boundary conditions varied: exchange, imposed temperature, imposed flow,
- validation partial of the matrix of thermal "mass" because one makes "a false" transient.

The results are not affected by the distortion of the meshes  $h/l=40$  .

## 1 Problem of reference

### 1.1 Geometry



Interior ray	$R_i = 0.30 \text{ m}$
External ray	$R_e = 0.35 \text{ m}$
Not $F$	$r = 0.32 \text{ m}$

### 1.2 Material properties

$$\lambda = 1 \text{ W/m}^\circ\text{C}$$

$$\rho C_p = 2 \text{ J/m}^3 \text{ }^\circ\text{C} \text{ (voluminal heat)}$$

### 1.3 Boundary conditions and loadings

- $[DC] \cup [AB]$ :  $\Phi = 0 \text{ W/m}^2$
- $[EA]$ :  $T = T_i = 100 \text{ }^\circ\text{C}$
- $[ED]$ :  $\Phi = \Phi_i = 1729.9091 \text{ W/m}^2$  (returning flow)
- $[CD]$ : : exchange  $h = h_e = 500 \text{ W/m}^2 \text{ }^\circ\text{C}$   
 $T = T_e = 17.03444 \text{ }^\circ\text{C}$

### 1.4 Initial conditions

To do this stationary calculation, a transitory calculation is done for which the boundary conditions are constant in time. This makes it possible to test elementary calculations of mass intervening in the first member as well as the second member.

## 2 Reference solution

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### 2.1 Method of calculating used for the reference solution

$$T(r) = T_i + \Phi \log\left(\frac{r}{R_i}\right)$$

$$\text{with: } \left\{ \begin{array}{l} \Phi = \frac{T_e - T_i}{\log\left(\frac{R_e}{R_i}\right)} \\ \text{les flux radiaux } \left(\lambda \frac{\partial T}{\partial r}\right) \text{ sur les parois du cylindre sont :} \\ \Phi_i = +\lambda \cdot \frac{\Phi}{R_i} \\ \Phi_e = +\lambda \cdot \frac{\Phi}{R_e} \end{array} \right.$$

$T_i$ : Temperature in skin "interns"  
 $T_e$ : Temperature in "external" skin

### 2.2 Results of reference

Temperatures and flow at the points  $A$ ,  $B$ ,  $D$ ,  $F$ .

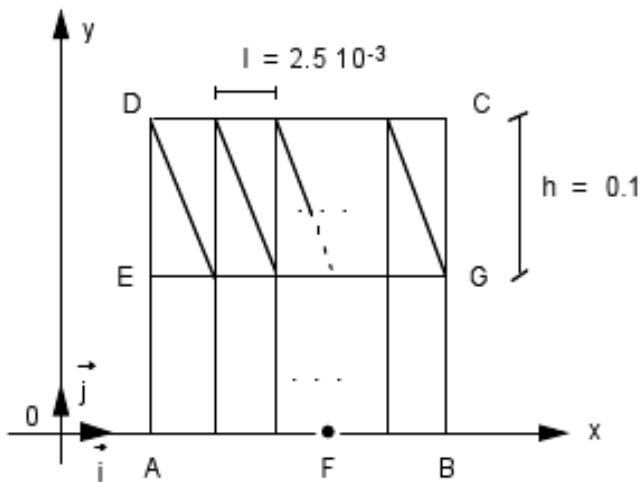
### 2.3 Uncertainty on the solution

Analytical solution.

## 3 Modeling A

### 3.1 Characteristics of modeling

axis (TRIA3, QUAD4)



	$x$	$y$	
$A$	0.30	0.00	$N1$
$B$	0.35	0.00	$N41$
$D$	0.30	0.10	$N43$
$E$	0.30	0.05	$N2$
$F$	0.32	0.00	$N17$

### 3.2 Characteristics of the grid

Many nodes: 63.

Many meshes and types: 40 TRIA3, 20 QUAD4

### 3.3 Values tested

Identification	Reference
$T(A)$	100
$T(B)$	20
$T(F)$	66,506
$T(D)$	100
$\Phi(A)$	1729.91
$\Phi(B)$	1482.78
$\Phi(D)$	1729.91
$\Phi(F)$	1621.79

## 4 Modeling B

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### 4.1 Characteristics of modeling

axis (TRIA6, QUAD8)

	$x$	$y$	
$A$	0.30	0.00	$N180$
$B$	0.35	0.00	$N10$
$D$	0.30	0.10	$N178$
$E$	0.30	0.05	$N183$
$F$	0.32	0.00	$N112$

### 4.2 Characteristics of the grid

Many nodes: 185.

Many meshes and types: 40 TRIA6, 20 QUAD8

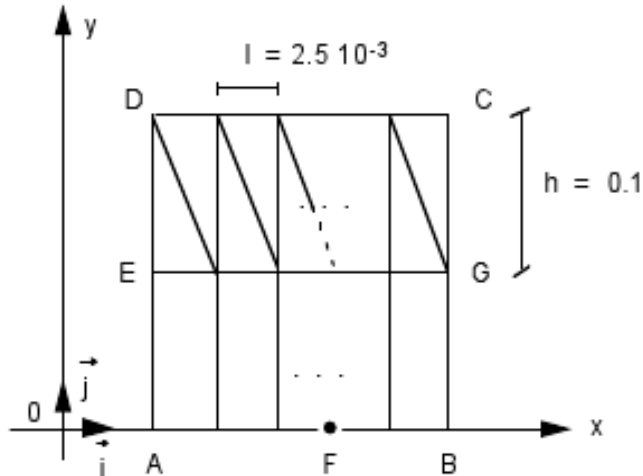
### 4.3 Values tested

Identification	Reference
$T(A)$	100
$T(B)$	20
$T(F)$	66,506
$T(D)$	100
$\Phi(A)$	1729.91
$\Phi(B)$	1482.78
$\Phi(D)$	1729.91
$\Phi(F)$	1621.79

## 5 Modeling C

### 5.1 Characteristics of modeling

axis (TRIA6, QUAD9)



	x	y	
A	0.30	0.00	N199
B	0.35	0.00	N10
D	0.30	0.10	N197
E	0.30	0.05	N203
F	0.32	0.00	N124

### 5.2 Characteristics of the grid

Many nodes: 205.

Many meshes and types: 40 TRIA6, 20 QUAD9

### 5.3 Values tested

Identification	Reference
$T(A)$	100
$T(B)$	20
$T(F)$	66,506
$T(D)$	100
$\Phi(A)$	1729.91
$\Phi(B)$	1482.78
$\Phi(D)$	1729.91
$\Phi(F)$	1621.79

## 6 Modeling D

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### 6.1 Characteristics of modeling

COQUE\_AXIS (SEG3)

### 6.2 Characteristics of the grid

Many nodes: 21.

Many meshes and types: 10 SEG3

### 6.3 Values tested

Identification	Size	Type of Reference	Reference	Tolerance (%)
$r=0.3(A)$		'ANALYTICAL'	100	0.1
$r=0.31$		'ANALYTICAL'	82.983	0.1
$r=0.32$	TEMP_SUP	'ANALYTICAL'	66.5063	0.1
$r=0.33$	TEMP_MIL	'ANALYTICAL'	50.5366	0.1
$r=0.34$	TEMP_INF	'ANALYTICAL'	35.0437	0.1
$r=0.35(B)$		'ANALYTICAL'	20	0.1

## 7 Summary of the results

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This problem is correctly solved:

- with the various types of elements whatever the degree of interpolation,
- is not affected by the shape of the elements  $h/l=40$  .