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## MTLP101 - Metallurgical calculation for a zircaloy

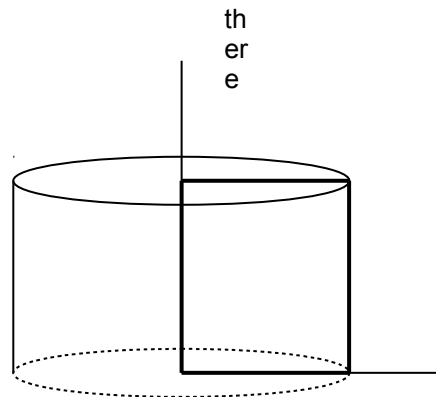
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### Summary:

The purpose of this test is to in the case of carry out calculation with the nodes of the metallurgical evolution associated with a thermal history a zircaloy.  
It takes part in the validation of the order `CALC_META`.

## 1 Problem of reference

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### 1.1 Geometry

Figure 1.1-a: Geometry of the problem

It is about a cylinder of ray  $0.05\text{ m}$  and height  $0.05\text{ m}$ .  
The square in fat corresponds to axisymmetric modeling used to [§3].

### 1.2 Material properties

The properties materials are described by the following parameters:

(Zirconium)

$$\rho C_p = 2000000 \text{ J.m}^{-3} . ^\circ\text{C}^{-1}$$

$$\lambda = 9999.9 \text{ W.m}^{-1} . ^\circ\text{C}^{-1}$$

Coefficients for the metallurgy:

$$teqd = 809^\circ\text{C}, K = 1.135\text{E}-2, n = 2.187$$

$$tlc = 831^\circ\text{C}, t2C = 0., qsr = 14614, Ac = 1.58\text{E}-4$$

$$m = 4.7, tlr = 949,1^\circ\text{C}, t2r = 0, Ar = -5.725, Br = 0.05$$

### 1.3 Boundary conditions and loadings

The temperature is imposed on all the cylinder on times  $t=0\text{s}$ ,  $120\text{s}$  and  $240\text{s}$ .

$$T(x, y, t=0) = 20^\circ\text{C}$$

$$T(x, y, t=120) = 1200^\circ\text{C}$$

$$T(x, y, t=240) = 20^\circ\text{C}$$

### 1.4 Initial conditions

The following variables are initialized with the following values:

$$V1(x, y, t=0) = 1.0$$

$$V2(x, y, t=0) = 0.0$$

$$V3(x, y, t=0) = 0.0$$

$$V4(x, y, t=0)=0.0$$

*V1* : proportion of the cold phase  $\alpha$

*V2* : proportion of the cold phase  $\alpha$  , mixed with the phase  $\beta$

*V3* : temperatures with the nodes

*V4* : time corresponding to or end the initial temperature of the transformation with balance

## 2 Reference solution

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### 2.1 Results of reference

The results of reference were got with a previous version of Aster.  
The tests carried out are tests of not-regression.

### 2.2 Uncertainty on the solution compared to the result of not-regression

The criterion of uncertainty is in absolute value. It is of  $[1E-4, 1E-2]$  .

## 3 Modeling A

### 3.1 Characteristics of modeling

The modeling used in the case test is the following one:

Elements 2D AXIS (QUA8)

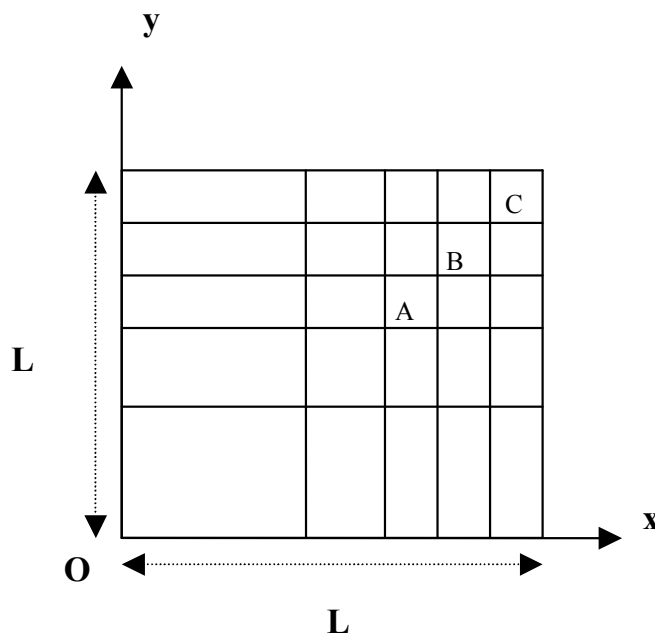


Figure 3.1-a: Geometry and grid of modeling used

Cutting: 5 meshes QUAD8 according to the axis of  $x$   
5 meshes QUAD8 according to the axis of  $y$

Nodes:

$A$  : mesh  $M13$  node  $N39$

$B$  : mesh  $M19$  node  $N66$

$C$  : mesh  $M19$  node  $N70$

### 3.2 Characteristics of the grid

Many nodes: 96

Many meshes and types: 25 QUAD8, 20 SEG3.

### 3.3 Sizes tested and results

Identification	Size	Reference
t=30s M13 N39	$V1$	1.0
t=30s M19 N66	$V3$	315.0
t=120s M13 N39	$V1$	0.0
t=120s M19 N66	$V3$	1200.0

t=240s M13 N39	V1	0.9999
t=240s M19 N70	V3	20.0

V1 : proportion of the cold phase  $\alpha$

V2 : proportion of the cold phase  $\alpha$  , mixed with the phase  $\beta$

V3 : temperatures with the nodes

V4 : time corresponding to or end the initial temperature of transformation with balance

## 4 Comments

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This case test of not-regression makes it possible to check the coherence of *Code\_Aster* from one version to another with regard to the metallurgy.