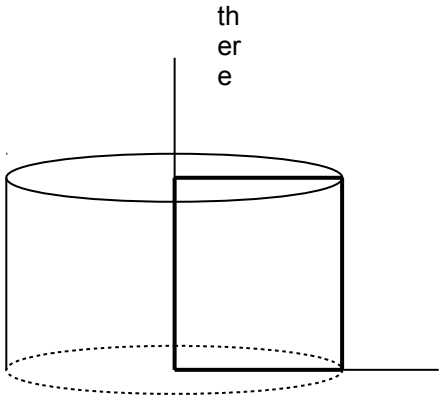
MTLP101 - Metallurgical calculation for a zircaloy

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



1.1 Geometry

Figure 1.1-a: Geometry of the problem

It is about a cylinder of ray $0.05m$ and height $0.05m$.
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)
$\rho C_P = 2000000 J.m^{-3}.°C^{-1}$
$\lambda = 9999.9 W.m^{-1}.°C^{-1}$
Coefficients for the metallurgy:
$teqd = 809°C$, $K = 1.135\text{E}-2$, $n = 2.187$
$t1c = 831°C$, $t2C = 0.$, $qsr = 14614$, $Ac = 1.58\text{E}-4$
$m = 4.7$, $t1r = 949{,}1°C$, $t2r = 0$, $Ar = -5.725$, $Br = 0.05$

1.3 Boundary conditions and loadings

The temperature is imposed on all the cylinder on times $t = 0\text{s}, 120\text{s}$ and 240s .
$T(x, y, t = 0) = 20°C$
$T(x, y, t = 120) = 1200°C$
$T(x, y, t = 240) = 20°C$

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 α
V2 : proportion of the cold phase α *, mixed with the phase* β
V3 : temperatures with the nodes
V4 : time corresponding to or end the initial temperature of the transformation with balance

2 Reference solution

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 $[1E\text{-}4, 1E\text{-}2]$.

3 Modeling A

3.1 Characteristics of modeling

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

Elements 2D AXIS (QUA8)

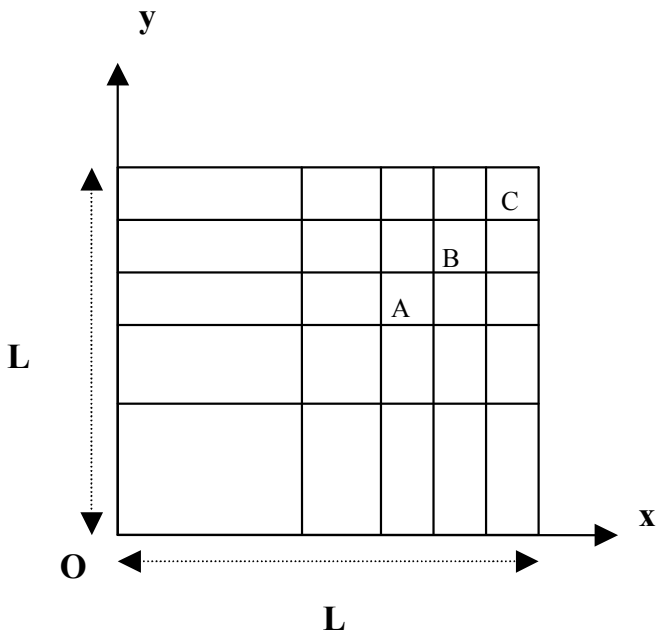


Figure 3.1-a: Geometry and grid of modeling used

Cutting: 5 meshs QUAD8 according to the axis of x
5 meshs 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 meshs 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 α
V2 : proportion of the cold phase α , mixed with the phase β
V3 : temperatures with the nodes
V4 : time corresponding to or end the initial temperature of transformation with balance

4 Comments

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.