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 $0.05 \text{ m}$ 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)

\[ \rho C_p = 2000000 \text{ J.m}^{-3}.\text{°C}^{-1} \]
\[ \chi = 9999.9 \text{ W.m}^{-1}.\text{°C}^{-1} \]

Coefficients for the metallurgy:

\[ t_{eqd} = 809 \, ^\circ \text{C}, \quad K = 1.135E-2, \quad n = 2.187 \]
\[ t_{1c} = 831 \, ^\circ \text{C}, \quad t_{2c} = 0, \quad q_{sr} = 14614, \quad Ac = 1.58E-4 \]
\[ m = 4.7, \quad t_{lr} = 949.1 \, ^\circ \text{C}, \quad t_{2r} = 0, \quad Ar = -5.725, \quad Br = 0.05 \]

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:

\[ V1(x, y, t = 0) = 1.0 \]
\[ V2(x, y, t = 0) = 0.0 \]
\[ V3(x, y, t = 0) = 0.0 \]
\[ V4(x, y, t = 0) = 0.0 \]

\[ V1 : \text{proportion of the cold phase } \alpha \]
\[ V2 : \text{proportion of the cold phase } \alpha, \text{ mixed with the phase } \beta \]
\[ V3 : \text{temperatures with the nodes} \]
\[ V4 : \text{time corresponding to or end the initial temperature of the transformation with balance} \]

## 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 \([1E-4, 1E-2] \).
3 Modeling A

3.1 Characteristics of modeling

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

Elements 2D AXIS (QUA8)

![Geometry and grid of modeling used](image)

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

<table>
<thead>
<tr>
<th>Identification</th>
<th>Size</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>t=30s M13 N39</td>
<td>$V1$</td>
<td>1.0</td>
</tr>
<tr>
<td>t=30s M19 N66</td>
<td>$V3$</td>
<td>315.0</td>
</tr>
<tr>
<td>t=120s M13 N39</td>
<td>$V1$</td>
<td>0.0</td>
</tr>
<tr>
<td>t=120s M19 N66</td>
<td>$V3$</td>
<td>1200.0</td>
</tr>
</tbody>
</table>

Warning: The translation process used on this website is a "Machine Translation". It may be imprecise and inaccurate in whole or in part and is provided as a convenience.

Copyright 2020 EDF R&D - Licensed under the terms of the GNU FDL (http://www.gnu.org/copyleft/fdl.html)
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.