TTLP301 - Transfer of heat in a perforated plate

Summary:

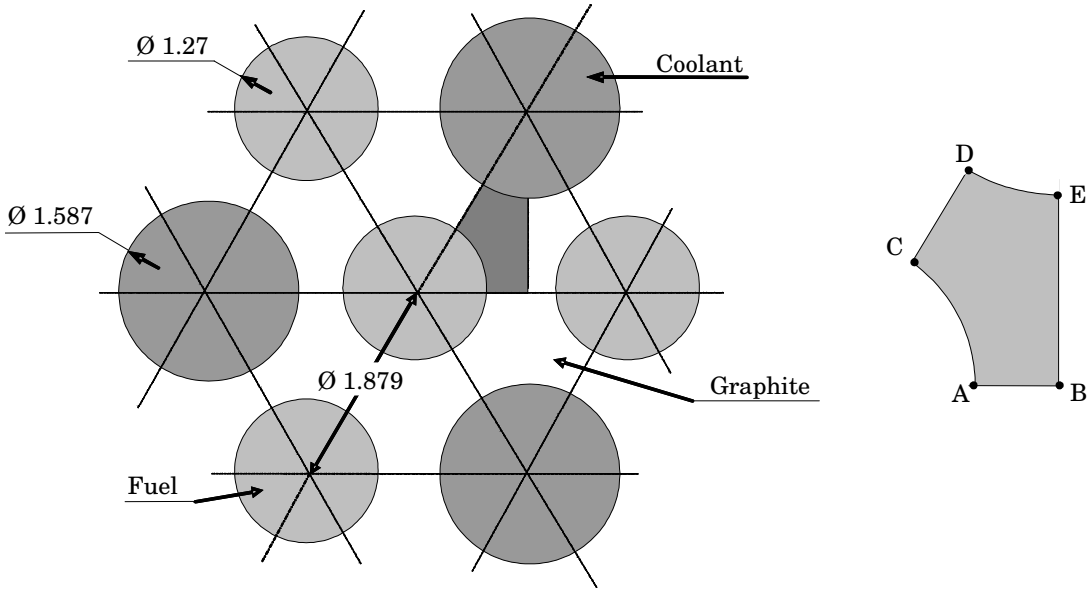
This test, industrialist, are resulting from the validation independent of version 3 in linear transitory thermics.

It is about a problem 2D plan represented by two modelings, one planes, the other voluminal one.

The features tested are the following ones:
- thermal element plan,
- voluminal thermal element,
- transitory algorithm of thermics,
- boundary conditions of exchange and flow.

1 Problem of reference

1.1 Geometry



The unit of the grid is the centimetre.

1.2 Properties of material

$\lambda = 0.1\ W/cm°C$ Thermal conductivity

$\rho C_P = 1.0\ J/cm^3°C$ Voluminal heat

1.3 Boundary conditions and loadings

- $[ED]$ Convection coefficient $h = 1\ W/cm^2°C$ $T_{ext} = 0°C$,
- $[AC]$ Density flux $q = 1\ W/cm^2$,
- $[AB]$, $[BE]$, $[DC]$ $\varphi = 0.$

1.4 Initial conditions

$T(t=0) = 0$

2 Reference solution

2.1 Method of calculating used for the reference solution

The reference solution is a digital solution obtained by the finite element method. This solution is based on a linear triangular network presented in the reference [1]. Calculations were carried out by considering an increment of time $\Delta t = 0.01\ s$.

2.2 Sizes and Résultats of reference

Temperature at the point C for $t = 0.1, 0.2, ..., 0.9, 1.0, 1.1, 1.2\ s$.

2.3 References bibliographical

[1] J. Donea, “One the accuracy of finite element solutions to the transient heat-conduction equation”, Int. J. num. Meth. Engng, flight 8, n°1, pp 103-110, 1974.

3 Modeling A

3.1 Characteristics of modeling

In modeling A, the structure is modelled by elements PLAN.

3.2 Characteristics of the grid

Many nodes: 718
Many meshs and types: TRIA6 : 335 (SEG3 : 22)

3.3 Sizes tested and results

Identification	Type of reference	Value of Référence	Precision
Not C - Moment 0.1	'SOURCE_EXTERNE'	1,045 $T(°C)$	3%
Not C - Moment 0.2	'SOURCE_EXTERNE'	1,447 $T(°C)$	2%
Not C - Moment 0.3	'SOURCE_EXTERNE'	1,742 $T(°C)$	2%
Not C - Moment 0.4	'SOURCE_EXTERNE'	1,982 $T(°C)$	2%
Not C - Moment 0.5	'SOURCE_EXTERNE'	2,189 $T(°C)$	2%
Not C - Moment 0.6	'SOURCE_EXTERNE'	2,373 $T(°C)$	2%
Not C - Moment 0.7	'SOURCE_EXTERNE'	2,541 $T(°C)$	2%
Not C - Moment 0.8	'SOURCE_EXTERNE'	2,698 $T(°C)$	2%
Not C - Moment 0.9	'SOURCE_EXTERNE'	2,846 $T(°C)$	2%
Not C - Moment 1.0	'SOURCE_EXTERNE'	2,986 $T(°C)$	2%
Not C - Moment 1.1	'SOURCE_EXTERNE'	3,120 $T(°C)$	2%
Not C - Moment 1.2	'SOURCE_EXTERNE'	3,248 $T(°C)$	2%

4 Modeling B

4.1 Characteristics of modeling

In modeling B, the structure is modelled by elements 3D.

4.2 Characteristics of the grid

Many nodes: 2538
Many meshs and types: PENTA15 : 670 (QUAD8 : 44)

4.3 Sizes tested and results

Identification	Type of reference	Value of Référence	Precision
Not C - Moment 0.1	'SOURCE_EXTERNE'	1,045 $T(°C)$	3 %
Not C - Moment 0.2	'SOURCE_EXTERNE'	1,447 $T(°C)$	2%
Not C - Moment 0.3	'SOURCE_EXTERNE'	1,742 $T(°C)$	2%
Not C - Moment 0.4	'SOURCE_EXTERNE'	1,982 $T(°C)$	2%
Not C - Moment 0.5	'SOURCE_EXTERNE'	2,189 $T(°C)$	2%
Not C - Moment 0.6	'SOURCE_EXTERNE'	2,373 $T(°C)$	2%
Not C - Moment 0.7	'SOURCE_EXTERNE'	2,541 $T(°C)$	2%
Not C - Moment 0.8	'SOURCE_EXTERNE'	2,698 $T(°C)$	2%
Not C - Moment 0.9	'SOURCE_EXTERNE'	2,846 $T(°C)$	2%
Not C - Moment 1.0	'SOURCE_EXTERNE'	2,986 $T(°C)$	2%
Not C - Moment 1.1	'SOURCE_EXTERNE'	3,120 $T(°C)$	2%
Not C - Moment 1.2	'SOURCE_EXTERNE'	3,248 $T(°C)$	2%

5 Summary of the results

Two modelings give results in concord with the reference solution, a relative variation lower than 2 % except locally on the smallest value of temperature and for the weakest moment the T (starting of the problem).

A finer grid in the zone of not C should improve quality of the results which are regarded as acceptable taking into account modelings carried out.