WTNV111 – Heat flux on a saturated porous environment

Summary:

One considers a three-dimensional problem of thermics in a saturated porous environment.

This test consists in studying the effect of the application of a flow of temperature on the higher face of the model on the distribution of the temperature in the element. First step of time is under investigation limited. One blocks the pressure and displacements.

The studied models are $2D$ plans (DPQ8 and DPTR6) and $3D$ voluminal (HEXA20) with a linear behavior.

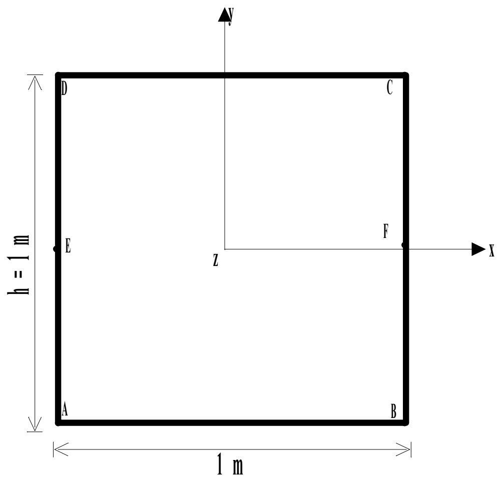
The reference solution is then the solution of a calculation in thermics pure (THER_LINEAIRE) with *Code_Aster.*

1 Problem of reference

1.1 Presentation

One studies in this case test the pure thermal behavior of a porous environment saturated by only one fluid: water in its liquid phase. It acts in *Code_Aster* of a modeling THM . The associated law of behavior of the fluid is of type LIQU_SATU .

1.2 Geometry



Coordinates of the points (m) :

$$A: -0,5 \ -0,5 \qquad C: \ 0,5 \ 0,5$$
$$B: \ 0,5 \ -0,5 \qquad D: -0,5 \ 0,5$$

1.3 Properties of material

solid	Density $(kg.m^{-3})$ Drained Young modulus $E(Pa)$ Poisson's ratio Thermal dilation coefficient of the solid (K^{-1})	2×10^3 $225.\times10^6$ $0.$ $8.\times10^{-6}$
Thermics	Homogenized conductivity $(W.K^{-1.}m^{-1})$ Derived from the conductivity homogenized compared to the temperature	1.7 $0.$
Coefficients of homogenisation	Coefficient of Biot Porosity	10^{-12} 0.4
Homogenized coefficients	Density $(kg.m^{-3})$ Heat with constant constraint $(J.K^{-1})$	1.6×10^3 2.85×10^6

1.4 Boundary conditions and loadings

- Complete element:
  - displacements $u_x=0.0\,m, u_y=0.0\,m, u_z=0.0\,m$.
  - pressure of the fluid $PRE1=0.0\,Pa$
- Lower face:
  - temperature $T=273\,K$
- Higher face:
  - heat flux $FLUN=0.5\,J.s^{-1}.m^{-2}$

1.5 Initial conditions

The fields of displacement, pressure, temperature are initially all worthless, but the temperature of reference is not worthless. It is worth $T_0=273\,K$.

2 Reference solution

2.1 Method of calculating used for the reference solution

The reference solution is the solution of a calculation in thermics pure (THER_LINEAIRE) with *code_Aster* .

2.2 Reference variable

$TEMP$: temperature

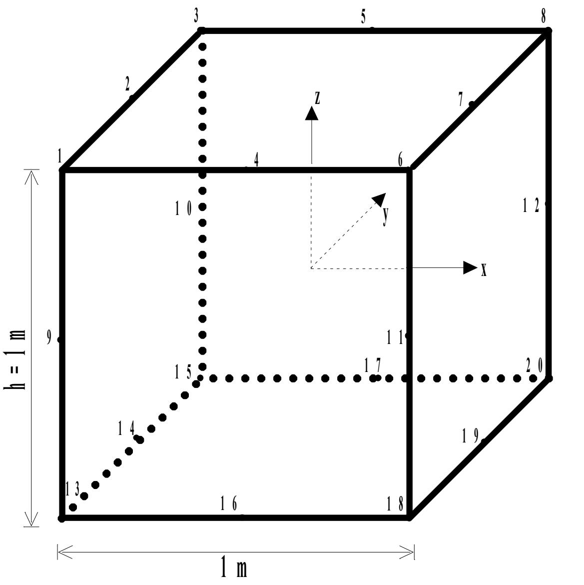
2.3 Size and result of reference

Not	Type of value	Moment (s)	Reference $(°C)$
C, D	$TEMP$	10^{13}	2.9412×10^{-1}
A, B	$TEMP$	10^{13}	$\approx 0.$

3 Modeling A

3.1 Characteristics of modeling A

Voluminal modeling: `3D_THM`



1 mesh `HEXA20` modeling `3D_THM` : `THM_HEXA20`

3.2 Result of modeling A

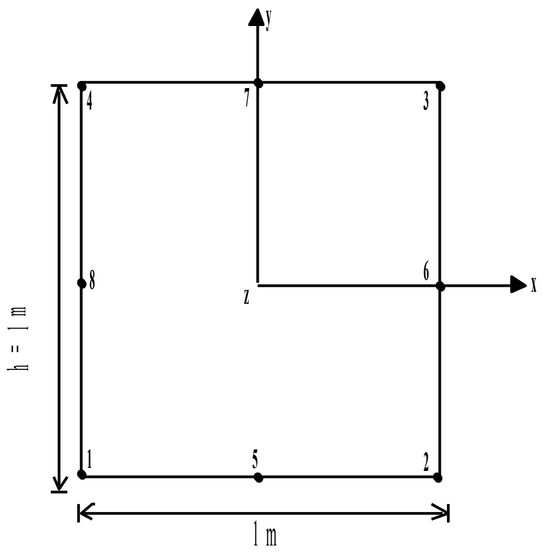
Discretization in time: only one step of large time: $10^{13}s$.
The diagram in time is implicit $(\vartheta=1)$.

Node	Type of value	Moment (s)	Reference $(°C)$	Tolerance
NO1	*TEMP*	10^{13}	2.9412×10^{-1}	$1.\%$
NO20	*TEMP*	10^{13}	$\approx 0.$	10^{-6}

4 Modeling B

4.1 Characteristics of modeling B

Plane modeling: `D_PLAN_THM`



1 mesh `DPQ8` modeling `D_PLAN_THM` : `THM_DPQ8`

4.2 Result of modeling B

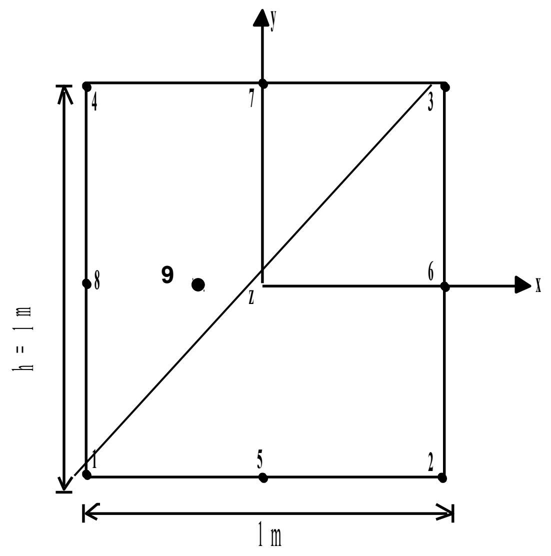
Discretization in time: only one step of large time: $10^{13} s$.
The diagram in time is implicit $(\vartheta = 1)$.

Node/Not	Type of Value	Moment (s)	Reference $(°C)$	Tolerance
$N3$ / C	*TEMP*	10^{13}	2.9412×10^{-1}	$1.\%$
$N1$ / A	*TEMP*	10^{13}	$\approx 0.$	10^{-6}

5 Modeling C

5.1 Characteristics of modeling C

Plane modeling: `D_PLAN_THM`



2 meshs `DPTR6` modeling `D_PLAN_THM` : `THM_DPTR6`

5.2 Result of modeling C

Discretization in time: only one step of large time: $10^{13} s$.
The diagram in time is implicit $(\vartheta=1)$.

Node/not	Type of Value	Moment (s)	Reference $(°C)$	Tolerance
N3 / C	*TEMP*	10^{13}	2.9412×10^{-1}	1.%
N1 / *A*	*TEMP*	10^{13}	$\approx 0.$	10^{-6}

6 Summary of the results

The variations observed between the reference solution and the Code_Aster solution are very weak. It there thus a good agreement of the results.