WTNL101 – Problem THM saturated coupled

Summary:

It is about a dimensional mono problem of THM saturated. The thermal loading is a constant heat flow at an end of the field. One observes the propagation of the pressure and the temperature in the bar. This test is a test of nonregression.

1 Problem of reference

1.1 Geometry

One places oneself within the framework of a monodimensional problem in Cartesian coordinates, corresponding to an assumption of plane deformations in the direction y.

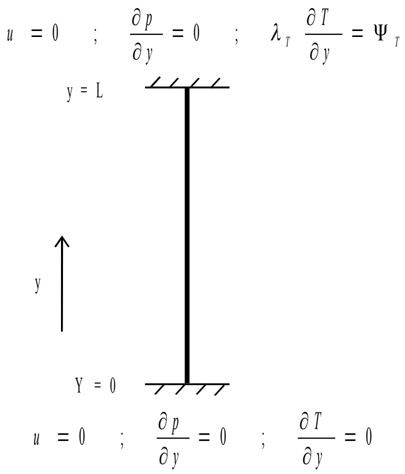
The "structure" considered, is finally a segment length $L=20\,m$.

1.2 Properties of material

Liquid water	Density $(kg.m^{-3})$ Specific heat with constant pressure $(J.K^{-1})$ Dynamic viscosity of liquid water $(Pa.s)$ Thermal dilation coefficient of the liquid (K^{-1}) Compressibility (Pa^{-1})	10^3 4180 0.001 1.10^{-4} $K_e=5.10^{-10}$
Solid	Drained Young modulus $E(Pa)$ Poisson's ratio Thermal dilation coefficient of the solid (K^{-1})	$2.166\,10^9$ 0.3 10^{-5}
Initial state	Porosity Temperature (K) Liquid pressure (Pa) Steam pressure (Pa)	0.14 293 0 2320
Homogenized coefficients	Homogenized density $(kg.m^{-3})$ Coefficient of Biot Intrinsic permeability (m^2) Thermal conductivity $(W.K^{-1}m^{-1})$ Heat with constant constraint $(J.K^{-1})$	2410 1 $K_{\text{int}}=10^{-19}$ $\lambda_T=1.8$ 565.

1.3 Boundary conditions and loadings

A vertical bar is heated:



With $\lambda_T \frac{\partial T}{\partial x} = \Psi_T$ independent of time t

What corresponds to:

- In $x=0$: null displacement, hydraulic flow no one, imposed heat flux $\Psi_T = 100\,W.m^{-2}$ constant in time
- In $x=L$: null displacement, hydraulic flow no one, heat flux no one.

1.4 Initial conditions

$u(x)=P(x)=0 \quad T(x)=T_0=20°C$ everywhere.

2 Reference solution

The test is here in nonregression. It is checked well that the temperature and the pressure are propagated by conductivity along the bar and that temperatures and pressures decrease as soon as one moves away from source of heat (Y=L).

3 Modeling A

3.1 Characteristics of modeling A

- Modeling in plane deformations.
- 100 elements $Q4$ of width equalizes for an overall length of 20 Mr.

Notice : like all modelings THM, the grid must be quadratic, but the digital processing is done on $Q4$.

3.2 Result of modeling A

Discretization in time: 10 pas de time of $50\,000\,s$ each one.

Table of nodes at the moment $5\times10^5 s$ **:**

$N°$ **NODE**	$COOR\_X$	$COOR\_Y$	$TEMP(°C)$	**Tolerance** $(\%)$	$PRE1(Pa)$	**Tolerance** $(\%)$
2	0	20	43.50	10	4.59×10^6	10
7	0	19.8	33.30	10	4.45×10^6	10
12	0	19.6	24.86	10	4.07×10^6	10
17	0	19.4	18.06	10	3.54×10^6	10
22	0	19.2	12.77	10	2.98×10^6	10

4 Modeling B

It is the same modeling in `THMS` (selective modeling). The results are the same ones.

5 Summary of the results

The results are into coherent physically (the temperature and the pressure are more important as soon as one approaches the source of heat) with what one awaits from this kind of problems.