WTNP118 - Gravitating rebalancing of the saturation of a column

Summary:

The test presented here makes it possible to check the good taking into account of gravity for the modeling of the unsaturated flows. This test represents a column initially uniformly désaturé. There is no loading: only gravity is driving evolution.

This test will be the object of a case test Alliances.

1 Problem of reference

1.1 Geometry

The studied field is a bar of $3\,m$.

Coordinates of the points (m) :

$A(0;0)$ $C(3;0.1)$
$B(3;0)$ $D(0;0.1)$

1.2 Properties of material

One takes data here bringing back to a quasi-unit problem. The units then do not have any more physical meaning.
Gravity is taken in the direction of x positive (which corresponds as a result to the vertical axis).

Liquid water	Density $(kg.m^{-3})$ Viscosity $(Pa.s)$	1 1
Gas	Viscosity $(Pa.s)$	1
Homogenized parameters	Gravity $(m.s^{-2})$ Permeability $K(m^2)$ Porosity Isotherm of sorption Relative permeability	$g=(9{,}81\ ;0\ ;0)$ 1 0.5 $S_{we}=\frac{1}{\left[1+\left(\frac{P_c}{1}\right)^{1,5}\right]^{1/3}}$ $kr_w(S)=1$ $kr_{gz}(S)=1$

1.3 Boundary conditions and initial

One is in worthless flows everywhere. Initially the medium is désaturé with a saturation of $S=0,5$ on the whole of the field what corresponds to a capillary pressure:
$Pc=3,6\,Pa$.
One measures an initial gas pressure of $1\,Pa$.

1.4 Pas de time

One models $1\,s$ in the following way:
- of 0 with $0,1\,s$: 5 pas de time
- of $0,1$ with $1\,s$: 9 pas de time

1.5 Reference solution

With the stationary state one must carry out hydrostatic balance.
It is necessary thus that $\Delta P_{lq}=\rho\,.\,g\,.\,\Delta x$
With the data which one lays out that thus gives us $\Delta P_{lq}=9,81*3=29,43\,Pa$

2 Modeling A

2.1 Characteristics of modeling A

Studied modeling is HHD in plane deformations. The grid is composed of 80 Q8 elements.

2.2 Features tested

This modeling makes it possible in particular to check the use of the temporal function PESA_MULT introduced into the map THM_DIFFU. This function is added in factor of the terms PESA_X, PESA_Y and PESA_Z, and allows to make gravity dependent on time.

2.3 Results

The figures below present the profiles of pressures capillary, gas pressures and saturation along the bar for various moments. One observes the rebalancing well to reach a stationary state (more nothing does not move afterwards $0,5\,s$).
In this stationary state and in Pa :

$Pgz(x=0)=0,991\,Pa$ and $Pgz(x=3)=1,014\,Pa$
$Pc(x=0)=22,8\,Pa$ and $Pc(x=3)=-6,62\,Pa$

What gives $\Delta P_{lq}=29,44\,Pa$ who corresponds well to hydrostatic balance.

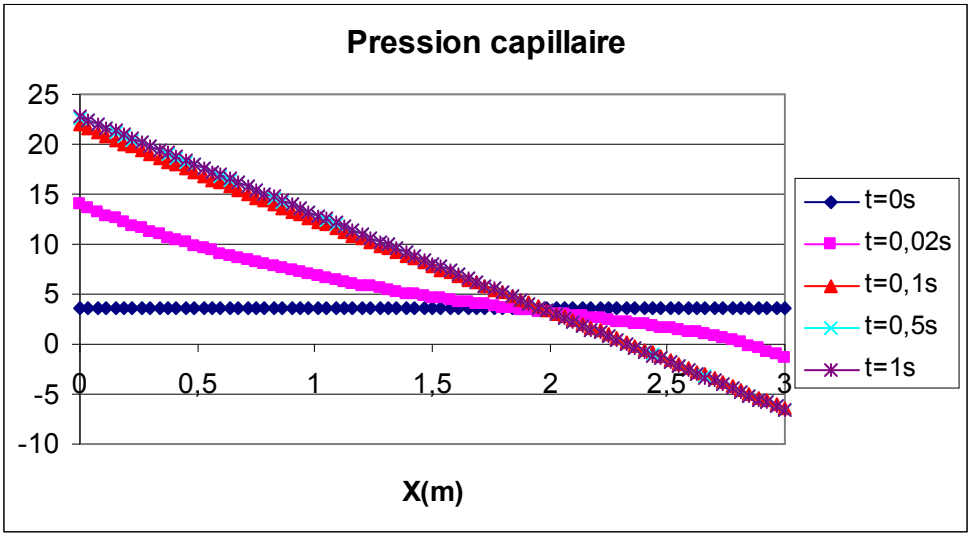

Figure 2.3-a : profiles of capillary pressure

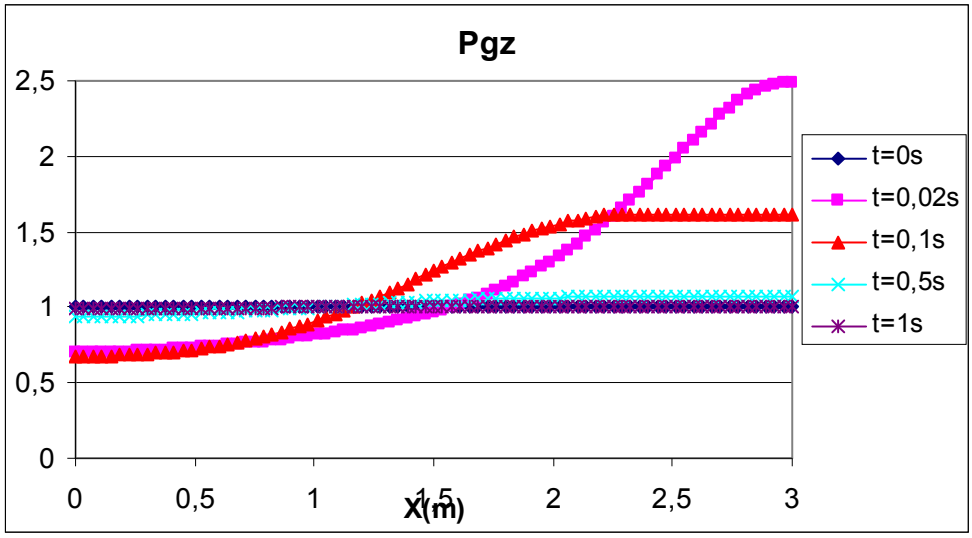

Figure 2.3-b : profiles of gas pressure

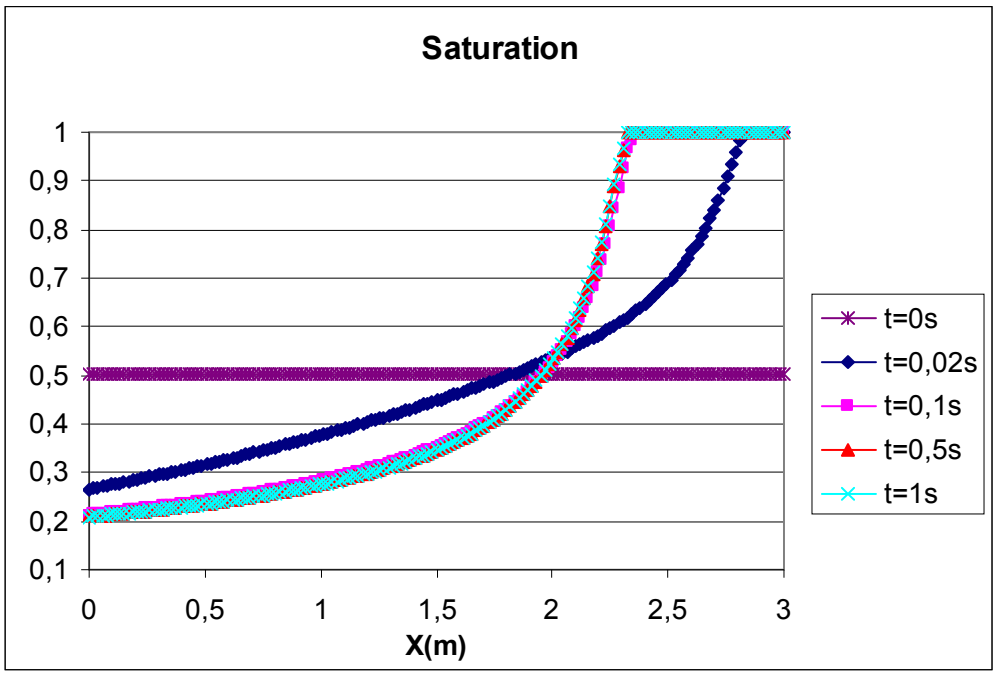

Figure 2.3-c : profiles of saturation

2.4 Value tested

$X(m)$	Time (s)	PRE1 Aster (Pa)	Authorized relative error
0.	0.02	13.94	0.1%
0.	0.1	21.92	0.1%
0.	1	22.79	0.1%

3 Modeling B

3.1 Characteristics of modeling B

Studied modeling is HH2D in plane deformations. The grid is composed of 80 Q8 elements. The purpose of this variation is to only pass by the law of behavior LIQU_AD_GAZ_VAPE with gravity. It is exactly the same test as previously but with a coefficient of Henry $K_H = \infty$ and all coefficients of Fick taken equal to 0.

3.2 Results

The results are of course the same ones as previously:

$X(m)$	Time (s)	PRE1 Aster	Authorized relative error
0.	0.02	13.94	0.1%
0.	0.1	21.92	0.1%
0.	1	22.79	0.1%

4 Modeling C

4.1 Characteristics of modeling C

Studied modeling is THH2D in plane deformations. The grid is composed of 80 Q8 elements. It is exactly the same case as modeling B but with a structure THH2D and thus of thermics (blocked). The purpose of this modeling is only to bring back itself to a structure of data THH2D in order to be able to make of them a case test Alliances (only modeling THH2D is known).

4.2 Results

The results are of course the same ones as previously:

$X(m)$	Time (s)	PRE1 Aster (Pa)	Authorized relative error
0.	0.02	13.94	0.1%
0.	0.1	21.92	0.1%
0.	1	22.79	0.1%

5 Synthesis

This case test makes it possible to validate the taking into account of gravity for the saturated cases. The got results are coherent.