# WTNV114 – Flux hydrous on a Summarized saturated porous environment

**:**

One studies the hydraulic behavior of a saturated porous environment. Four modelizations are carried out: two modelizations two-dimensional (modelizations A and B) and two modelizations three-dimensional (modelizations C and D).
The distinction between the modelizations A and B (respectively C and D) lies in the constitutive law of the fluid.

This test consists in applying a hydrous flux to the upper face of the model and studying the effect of this flux on the distribution of the pressure of the fluid in the saturated medium. It is about an evolutionary problem.

The studied models are 2D plane (`HM_DPQ8`) and 3D voluminal (`HM_HEXA20`) with a linear behavior.

The reference solution is unidimensional because it depends only on the vertical coordinate.

# 1 Problem of reference

## 1.1 Presentation

One studies in this case test the hydraulic behavior of a saturated porous environment consisted only one fluid: water in its liquid phase. It acts in *Code_Aster* of a modelization HM . The associated constitutive law of the fluid is according to the modelizations either of type LIQU_SATU (modelizations A and C) or of type LIQU_GAZ_ATM (modelizations B and D).

## 1.2 Geometry

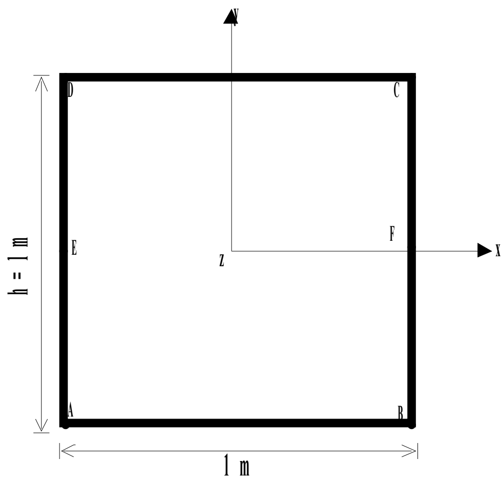


**Illustration 1: Geometry**

Coordinated of the points $(m)$ :

$A(-0.5,-0.5)$ ; $C(0.5,0.5)$
$B(0.5,-0.5)$ ; $D(-0.5,0.5)$

## 1.3 Properties of the liquid

| | | |
|---|---|---|
| material Water | Density $(kg.m^{-3})$<br>Dynamic viscosity of liquid water $(Pa.s)$<br>Solid $(Pa^{-1})$ | $10^3$<br>$0.001$<br>$K_e=3.77 10^{-9}$ |
| Compressibility | Young Modulus drained $E(Pa)$<br>initial | $225 10^6$<br>$0$ |
| State Poisson's ratio | Porosity<br>liquid $(K)$<br>Temperature Pressure $(Pa)$<br>Steam pressure $(Pa)$ | $0.4$<br>$273$<br>$0$<br>$1$ |
| Constants | Constant of perfect gases | $8.32$ |
| homogenized Coefficients | Isothermal homogenized Density $(kg.m^{-3})$<br>of sorption<br>Coefficient of intrinsic<br>Biot Permeability $(m^2)$ | $1600$<br>$S(P_c)=1$<br>$1$<br>$K_{\text{int}}=10^{-18}$ |

**Table 1.3-1: Data materials**

## 1.4 Boundary conditions and loadings

complete Element:
blocked displacements $u_x=u_y=u_z=0$
Upper face:
hydrous flux: $Q_{lq}=0.005\ kg.s^{-1}.m^{-2}$
Lower face:
hydrous flux $Q_{lq}=0$

side Sides:
Elsewhere: null flux

## 1.5 Initial conditions

the fields of displacement, of fluid pressure is initially null and the reference temperature is worth $T_0=273°K$.

# 2 Reference solution

the reference solution is unidimensional because it depends only on the vertical coordinate. The test is carried out here into non regression.

***Note:*** This modelization is carried out on linear elements in hydraulics and thermal. An analytical solution was conceived at the origin for this test then into quadratic: the computation of a new adapted analytical solution is the object of file 16737.

# 3 Modelization A

## 3.1 Characteristic of the modelization A

- •Modelization in plane strains D_PLAN_HM.
- •Behavior hydraulic LIQU_SATU.
- •1 elements $Q8$ .

## 3.2 Result of the modelization A

Discretization in time: 7 time step growing. The list of time in seconds is: $(1,5,10,50,100,500,1000)$ .

**Table of nodes at time :**

| $N°$ **NODE** | **Sequence number** | $PRE1(Pa)$ | **Tolerance** $(\%)$ |
|---|---|---|---|
| $N1, A$ | 1 | $-6.625\times10^{3}$ | 5 |
| | 2 | $-3.310\times10^{4}$ | 5 |
| | 3 | $-6,611\times10^{4}$ | 5 |
| | 4 | $-3.301\times10^{5}$ | 5 |
| | 7 | $-6,520\times10^{5}$ | 5 |
| $N3, C$ | 1 | $1.325\times10^{4}$ | 5 |
| | 2 | $6.618\times10^{4}$ | 5 |
| | 3 | $1.322\times10^{5}$ | 5 |
| | 4 | $6.603\times10^{5}$ | 5 |
| | 7 | $1.312\times10^{7}$ | 5 |

**Table 1: Modelization**

# 4 results B

It acts of the same modelization but with a hydraulic constitutive law LIQU_GAZ_ATM. There is thus a constant gas phase with 1atm (assumption of Richard). The results are logically exactly the same ones as above.

# 5 Modelization C

It acts of the same modelization as in A but on a cube 3D (1 element HEXA20). The conditions on the sides of front and from behind are null flux and displacements. It is thus the same case that in 2D and the results are logically identical.

# 6 Modelization D

It acts of the same modelization as in C but with a hydraulic constitutive law LIQU_GAZ_ATM. There is thus a constant gas phase with 1atm (assumption of Richard). The results are logically exactly the same ones as above.

# 7 Modelization E

Exactly the same case as the modelization F but by testing option `SYME=' OUI' of` the linear solver.
The results are logically the same ones as for the modelization F.

# 8 Summary of the results

the results are coherent physically and will have to be consolidated by an analytical solution if possible (file 16737).