WTNP126 - Gas injection in a Summarized fractured porous

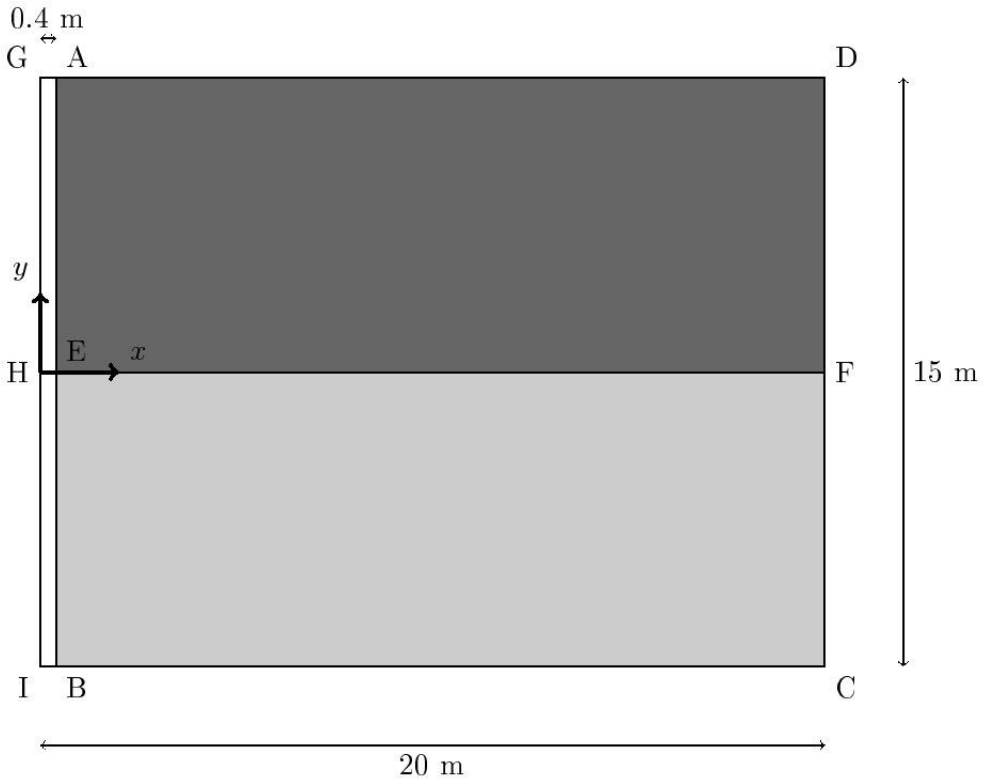
solid mass:

The test presented here makes it possible to check the correct operation of the elements of joints with coupling-hydromechanics in medium saturated with gas (model THM "GAZ").
One models the injection of dihydrogene in a rock solid mass. This one is composed of two elastic parts of different permeabilities separated by a water seal. The constitutive laws of the interface used are the cubic model for the flow and the model of Bandis for the mechanics.

1 Problem of reference

1.1 Geometry

the studied field consists of two porous solid masses ($AEFD$ and $EBCF$) separated by a water seal. One also models clearance between structure and the wall of injection of gas ($AGIB$).



Coordinates of the points (in meters):

	x	y		x	y		x	y
A	0,4 .7, 5		D	20. 7,5		G	0. 7, 5. 0, 4	
B		-7,5	E	0,4	0	H	0	0
C	20	-7,5	F	20	0	I	0	-7,5

1.2 Properties of the material

•Properties of the fluid intersticiel (dihydrogene):

Molar mass	$0{,}002\ kg.m^{-3}$
Viscosity	$9.10^{-6}\ Pa.s$

•Properties of the higher rock matrix:

The matrix is elastic and has the following properties:

Young modulus	$3{,}0\,GPa$
Poisson's ratio	$0{,}12$
intrinsic	$0{,}18$
Porosity Permeability	$2{,}75.10^{-20}\,m^2$

•Properties of the lower rock matrix:

The lower rock matrix has the same mechanical characteristics that the higher matrix, but has an intrinsic permeability ten times lower.

Young modulus	$3{,}0\,GPa$
Poisson's ratio	$0{,}12$
intrinsic	$0{,}18$
Porosity Permeability	$2{,}75.10^{-21}\,m^2$

•Properties of discontinuity:

The structural mechanics behavior of discontinuity is described by the model of Bandis. Hydraulic flow is given by the cubic model.

Normal stiffness initial	$1.10^9\,Pa.m^{-1}$
initial asymptotic Opening	$0{,}4\,mm$
Coefficient γ	2

•Properties of clearance:

Clearance between the walls of emission of flux of dihydrogene and the rock is a springy medium far from rigid and of very high permeability.

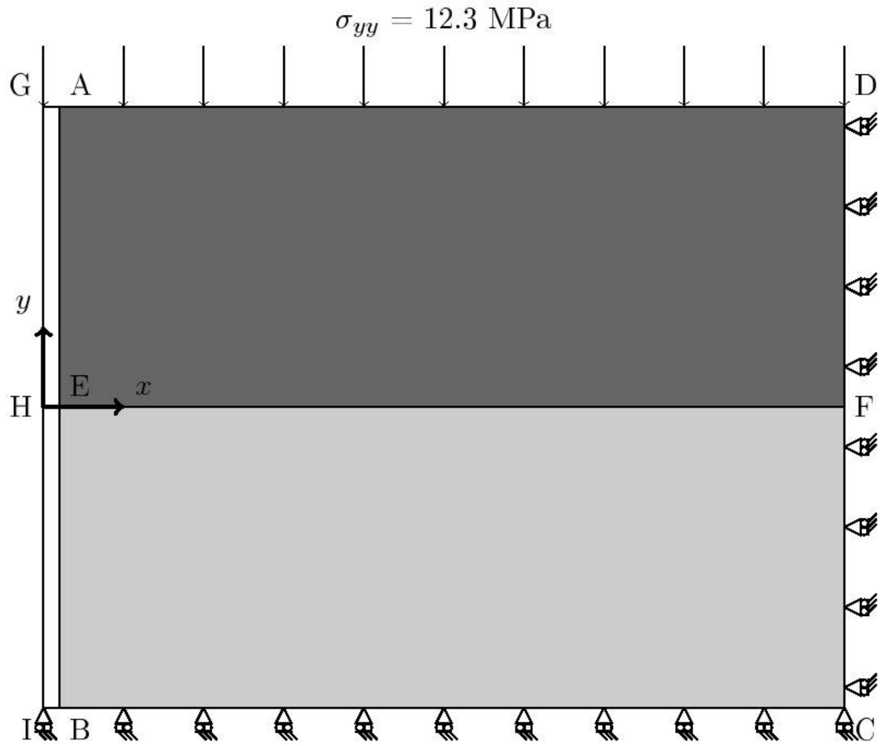
Young modulus	$3{,}0\,MPa$
Poisson's ratio	$0{,}12$
intrinsic	1
Porosity Permeability	$1.10^{-8}\,m^2$

1.3 Boundary conditions and loading

the hydraulic boundary conditions are the following ones:

On $[GD]$ hydraulic flux no one
On $[DC]$ $p_g=p_0=0{,}1\,MPa$
On $[CI]$ hydraulic flux no one
On $[IG]$ gas flux $F_g=1.10^{-10}\,kg.s^{-1}.m^{-2}$

the mechanical boundary conditions are given by the figure below.



1.4 Initial conditions

the initial conditions are the following ones:

- •initial opening: $3{,}48.10^{-6} m$
- •initial pressure in the solid mass: $p_0 = 0{,}1\ MPa$
- •compressive stress in the direction y : $12{,}3\ MPa$
- •temperature: $303\ °K$

2 Reference solution

One carries out tests of non regression.

3 Modelization A

3.1 Characteristic of the modelization

The modelization is carried out in plane strain with 100 elements `QU4` for clearance, 3202 elements `TRI3` for the solid mass and 100 elements `QU4` for discontinuity.

Discretization in time: 24 time step for a 1000 years simulation.

3.2 Quantities tested and results

figure 3.2.1 shows the profiles of pressure on the vertical cut $x=4m$ at various times. One sees well there the hydraulic influence of crack. Indeed, in the vicinity of this one one observes very important gradients of pressure who correspond to flux directed towards each of the two solid masses. In addition, one also sees the effect of the difference in permeability between the two solid masses. In accordance with until one waits, the pressure is standardized more quickly in the higher solid mass, of higher permeability.

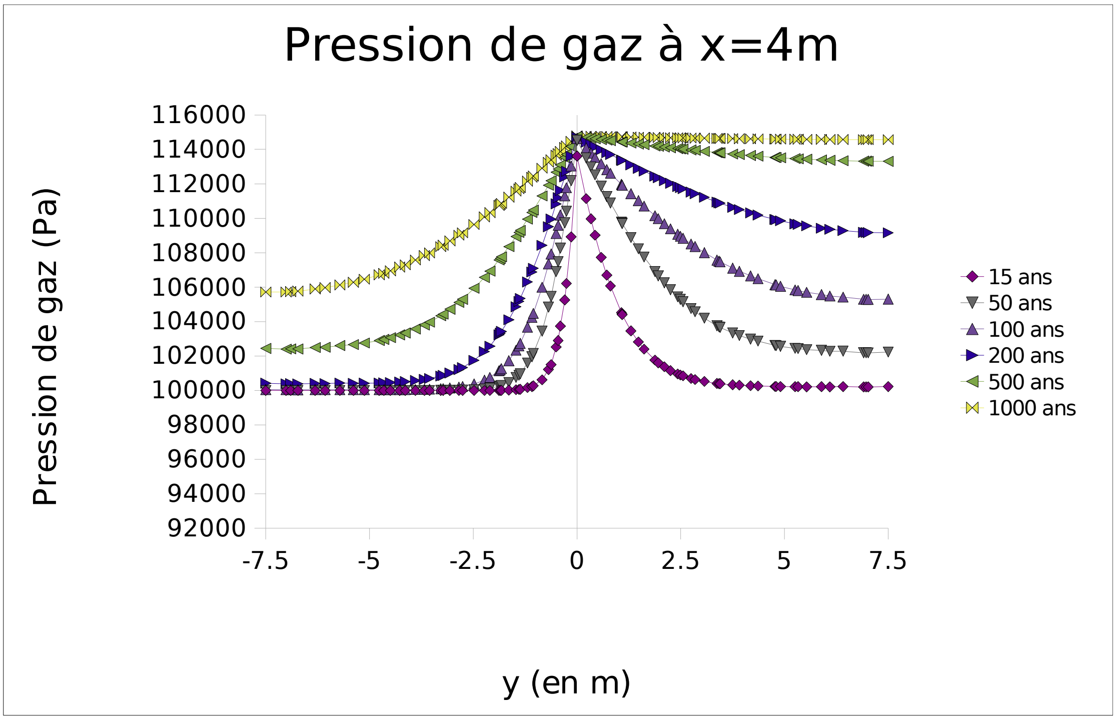


Figure 3.2.1: Profiles of gas pressure along a vertical cut (x=4m)

One carries out the test of NON-regression following:

$X(m)$	$Y(m)$	Time (years)	$PRE1(Pa)$ Aster
4,23	2,35	200	1,1159E+05
4,23	2,35	1000	1,1447E+05
3,92	-2,58	200	1,0135E+05
3,92	-2,58	1000	1,0929E+05
4,0.0,0. 200			1,1470E+05

4,0.0,0	1000	1,1477E+05

4 Modelization B

4.1 Characteristic of the modelization

the characteristics of simulation are identical to those of the modelization above but the interface transversely becomes impermeable. One imposes on the hydraulic Lagrange multipliers which control the equality of pressure through the interface to be equal to zero. For that, one uses command `AFFE_CHAR_CINE` MECA_IMPO `with the key word` to put the degree of freedom $LH1$ at 0 on crack.

4.2 Quantities tested and results

figure 4.2.1 shows the profiles of pressure along the cut vertical $x=4m$ at various times. It is noted well that there is no exchange between the two solid masses and crack. In addition, the fronts of pressure advance at a different velocity in each solid mass because of difference in permeability.

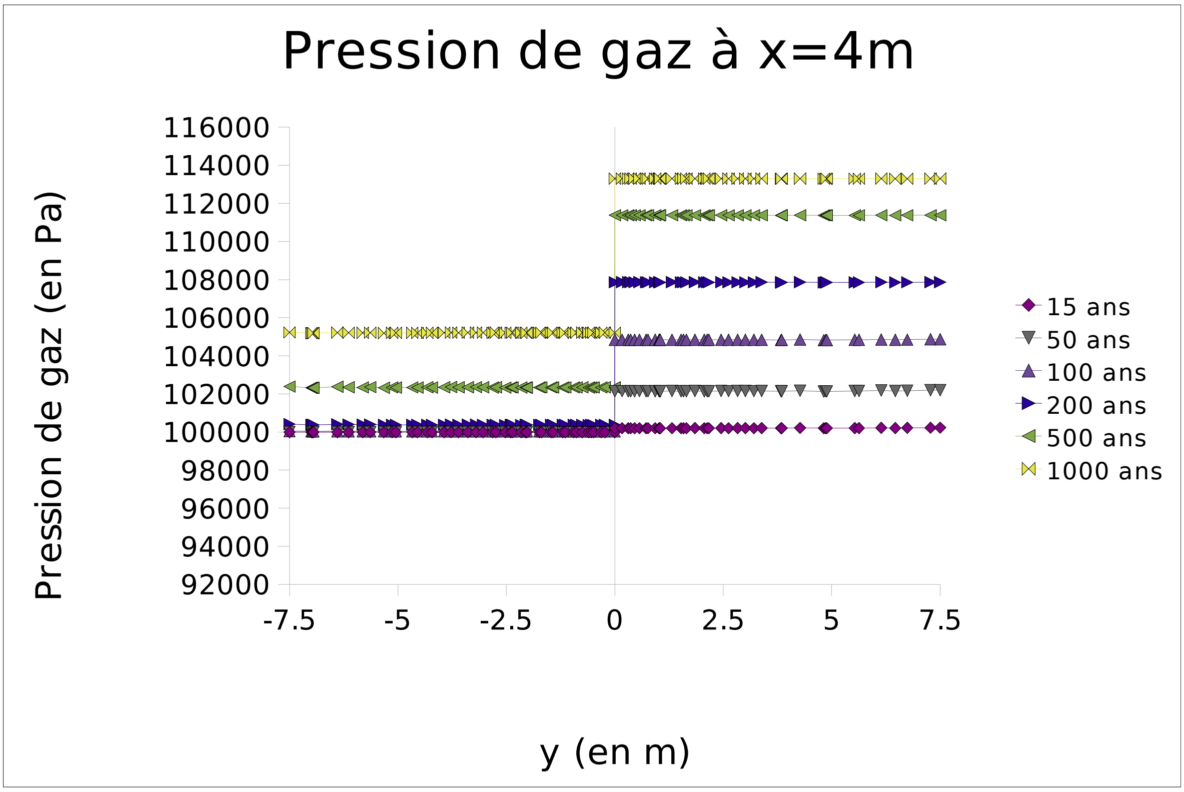


Figure 4.2.1: Profiles of gas pressure along a vertical cut (x=4 m)

One carries out the test of NON-regression following:

$X(m)$	$Y(m)$	Time (years)	$PRE1(Pa)$ **Aster**
4,23	2,35	200	1,073E+05
4,23	2,35	1000	1,13E+05
3,92	-2,58	200	1,0041E+05
3,92	-2,58	1000	1,0539E+05
4,0.0,0. 200			1,1473E+05

4,0.0,0	1000	1,1477E+05

5 Summary of the results

One tests the element of joint with hydraulic coupling and its compatibility with coupling law "the GAZ" and the elements of solid mass HM_DPTR6S. One considers the case where the joint is impermeable or not.

In both cases, one gets the qualitatively expected results.