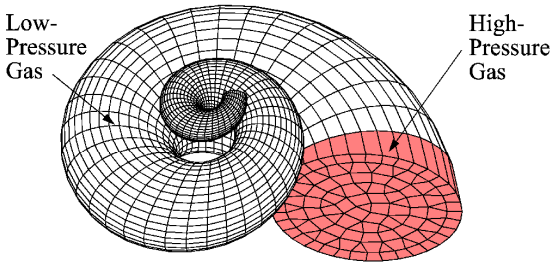
Exercise/Example 3 – Wave propagation in 3-D rigid tank

The rigid outer surface has a complex 3-D shape.

- Try out ALE solution with FSR



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Geometric data:

Complex shell-like 3D shape. The walls are assumed to be rigid, so this is a purely fluid problem.

Materials

The explosive bubble is made of a high-pressure perfect gas. The rest of the domain is filled by the same gas but at a lower pressure.

Numerical Solution

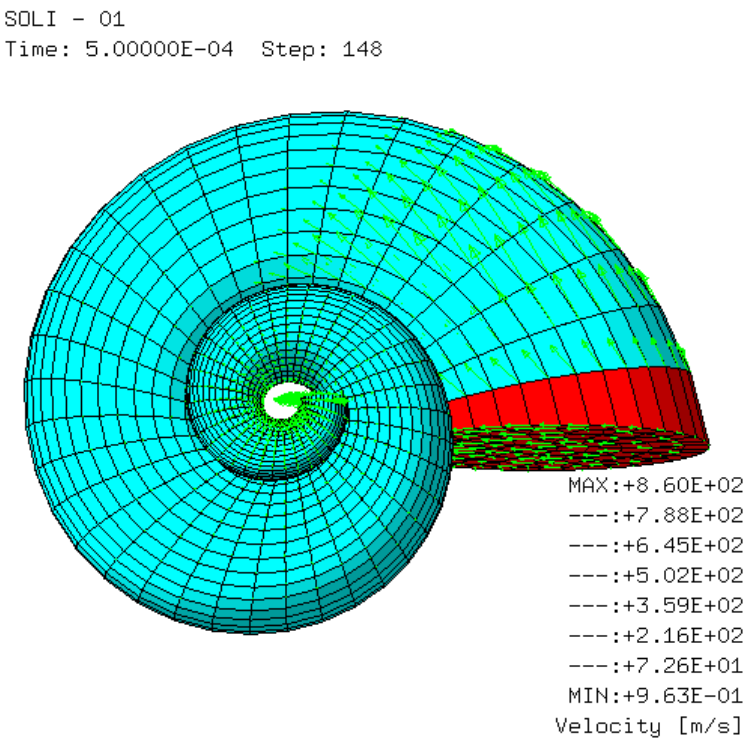
SOLI01

We use the FSR directive to prescribe the boundary conditions at the complex 3D surface of the domain. The input file is:

```
SOLI - 01
*------------------------------------------------------------------
 ECHO
 CONV win
CAST MESH
*-------------------------------------------------------------Problem type
TRID NONL EULE
*-------------------------------------------------------------Dimensioning
DIME
 PT3L 8760 FL38 6264 FL36 2016 ZONE 2
 NALE 1 NBLE 1
 MTEL 115
TERM
*------------------------------------------------------------------Geometry
GEOM FL38 SUR8 FL36 SUR6 TERM
*-----------------------------------------------Geometric Complements
COMP COUL roug LECT sur1 TERM
          turq LECT sur2 TERM
*-----------------------------------------------------Material data
MATE FLUT RO 1.22 EINT 3.046E6 GAMM 1.269 PB 0
          ITER 1 ALF0 1 BET0 1 KINT 0 AHGF 0 CL 0.5
          CQ 2.56 PMIN 0 NUM 1
          LECT SUR1 TERM
     FLUT RO 0.1237 EINT 3.046E6 GAMM 1.269 PB 0
          ITER 1 ALF0 1 BET0 1 KINT 0 AHGF 0 CL 0.5
          CQ 2.56 PMIN 0 NUM 1
          LECT SUR2 TERM
*-----------------------------------------------Boundary conditions
LINK COUP FSR LECT FSRN TERM
*-------------------------------------------------------------------Outputs
ECRI VITE ECRO TFRE 3.5E-3 ELEM LECT SUR1 TERM
     FICH K2000 TFRE 0.5E-3 POIN TOUS
                VARI DEPL VITE ECRO ECRC LECT 1 TERM
```

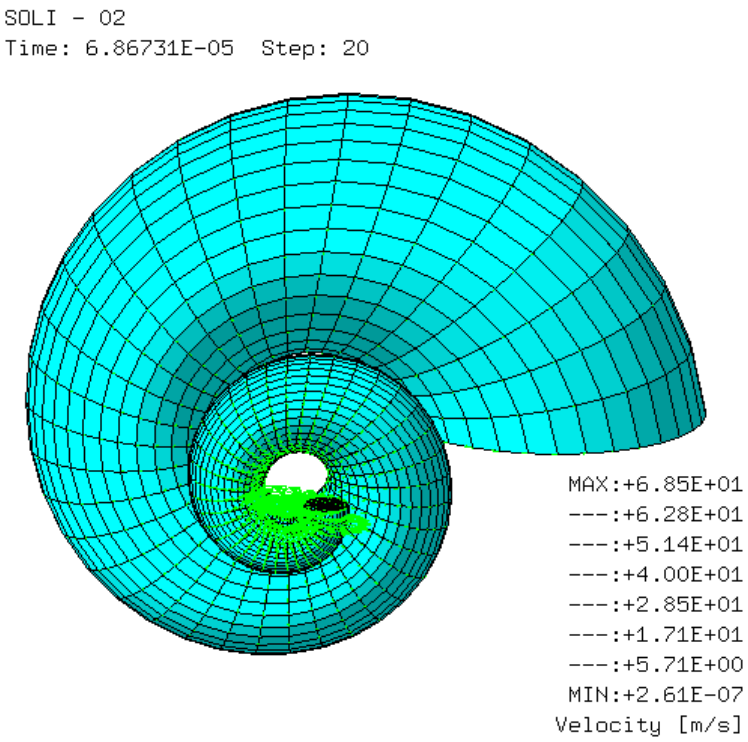
```
*-------------------------------------------------------------------Options
OPTI NOTE
     CSTA 0.5
     LOG 1
*-----------------------------------------------Transient calculation
CALCUL TINI 0 TEND 0.5E-3
*=================================================================ANIMATION
PLAY

CAME   1 EYE   2.95448E-01 -1.39852E+00  8.01450E+00
!        Q     9.96195E-01  8.71557E-02  0.00000E+00  0.00000E+00
         VIEW  0.00000E+00  1.73648E-01 -9.84808E-01
         RIGH  1.00000E+00  0.00000E+00  0.00000E+00
         UP    0.00000E+00  9.84808E-01  1.73648E-01
         FOV   1.68819E+01

scen
     vect scav
     text vsca
     lima on
     colo pape

sler cam1 1 nfra 1

freq 0 tfre 0.5e-3

go
trac offs fich bmp rend

ENDPLAY
*=====================================================================
FIN
```

At 0.5 ms, spurious (non-physical) velocities appear at the thin end of the fluid domain:



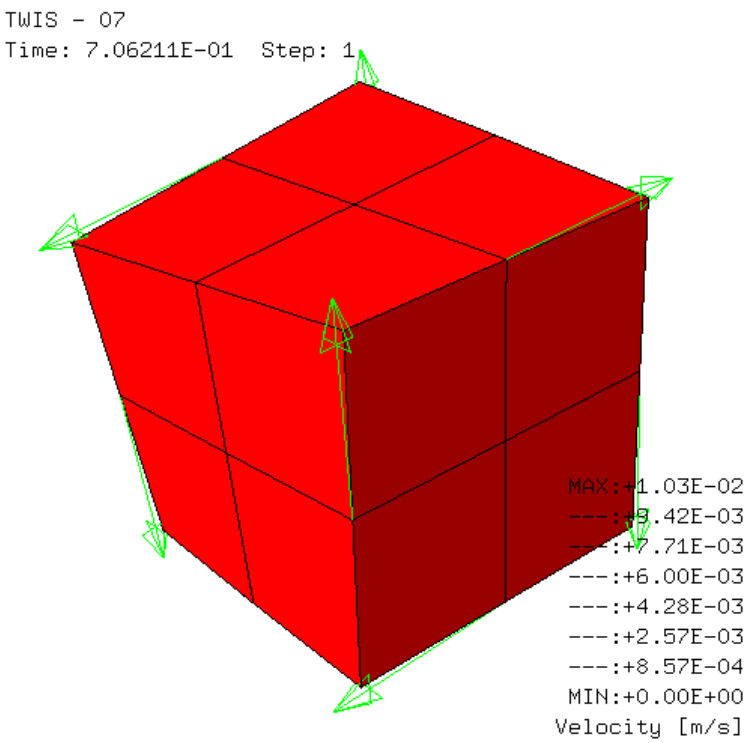
SOLI02

Same as SOLI01 but the entire domain is at the same (low) pressure and should therefore be in equilibrium. After only 20 steps, we see the development of non-negligible, spurious fluid velocities:



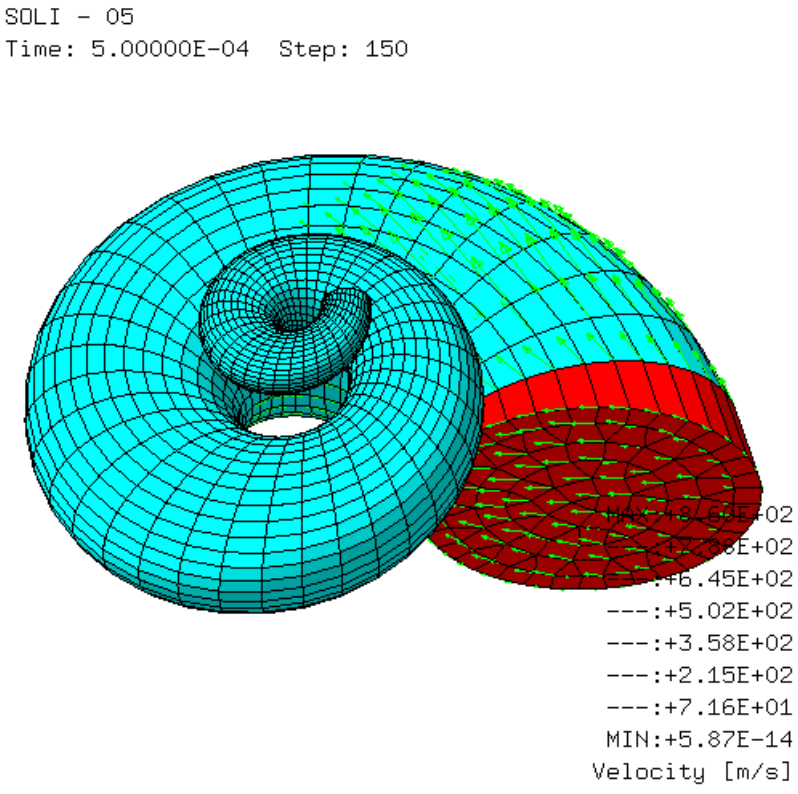
TWIS07

We study the phenomenon by a simple patch test of 8 fluid elements with uniform pressure and a warped geometry. Here is the result after just one time step:



SOLI05

To avoid the spurious velocities, we use the FSCR method (FSCR input option)



Here is an example of the computed pressures and velocities: