Cir Cyl Re100

1 Introduction

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Report generated 25/06/2020.

1.1 Description

Oscillating flow behind a circular cylinder perpendicular to the flow.

1.2 Parameters TRUST

- Version TRUST : 1.6.1
- Binary: /export/home/jd249769/TRIO_CFD/depots_git/triocfd-code/TrioCFD_opt (built on TRUST v/export/home/jd249769/TRIO_CFD/depots_git/triocfd-code/validation/share/Validation/Rapports_automatique
- Type of problem: 2D laminar hydraulic_problem
- Discretization: VEFPreP1B
- Time scheme: Euler Explicite for VDF and VEF
- Momentum convection scheme: EF_stab with alpha = 0.2 or Muscl
- Solving of equations: Navier_Stokes_standard

1.3 Test cases

- EI/Muscl/test.data :
- EI/EF_stab02/test.data :

1.4 References :

- [1] Chabard J.P, Lalanne P., Metivet B., Projet N3S de Mecanique des fluides. Cahier de Validation 2D. EDF/DER HE-41/88.08 1988.
- [2] Braza P., Chassaing P., H. Ha Minh, Numerical study and physical analysis of pressure and velocity fields in the near wake of a circular cylinder. J. Fluid Mech. 165, 79-130, 1986

2 Tests Description

Hydraulic initial conditions: quiescent fluid U = V = 0 m/s
Hydraulic boundary condition:
• The velocity is fixed in order to obtain U = 0.03937m/s in such a kind that Re = Ud/ν = 100
• CERCLE paroi_fixe
• PAROI1 symetrie
• PAROI2 symetrie
• SORTIE frontiere_ouverte_pression_imposee Champ_Front_Uniforme 1 0.0

• SORTIE frontiere_ouverte_vitesse_imposee Champ_Front_Uniforme 2 0.03937 0.0

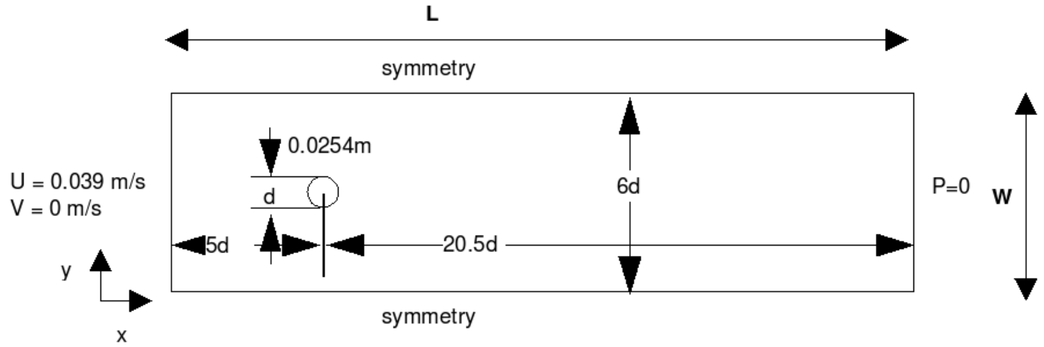
Validated model:

- No-slip at the wall
- 2D channel
- Disturbance of a laminar flow

Validation with: Calculations N3S of Chabard [1] and experiments of Braza et al. [2]

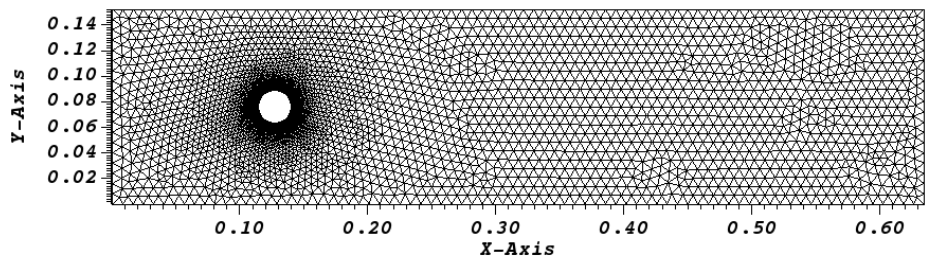
2.1 Geometry

In the follwing scheme, L = 0.635m ; W = 0.1524m and d = 0.0254m



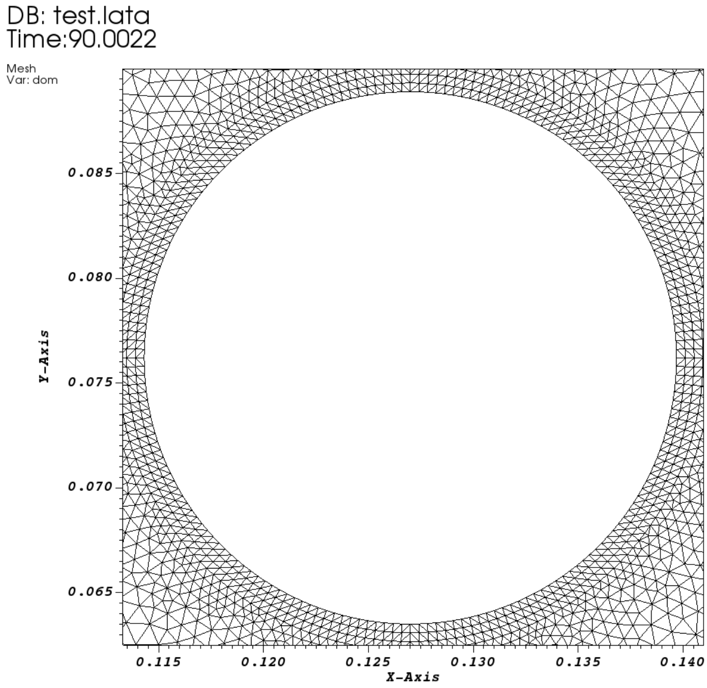
2.2 Mesh overview

Mesh build with Gmsh: 9668 elements



2.3 Zoom of the vicinity of the cylinder

Triangle layer with 200 points around the circle



2.4 Physical properties

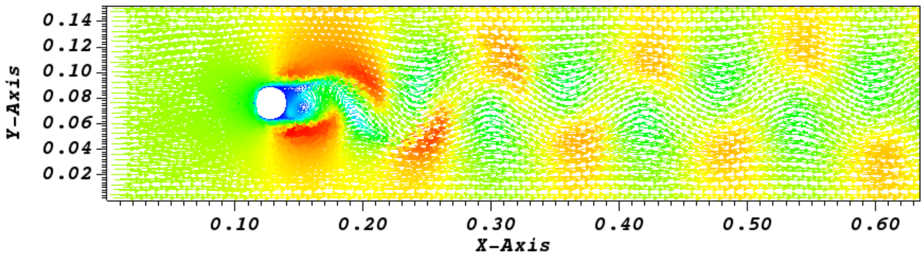
	Value
ρ (kg/m^3)	1.33
μ (N/m^2/s)	1e-05
Re	100.0

3 Results

The temporal pressure course at two probes located on the cylinder surface (y = -0.5d and y = +0.5d) is shown in the following figure for each convection scheme. The simulations have been perfomed up to 90s of physical time in order to get sufficient cycles allowing the calculation of a frequency.

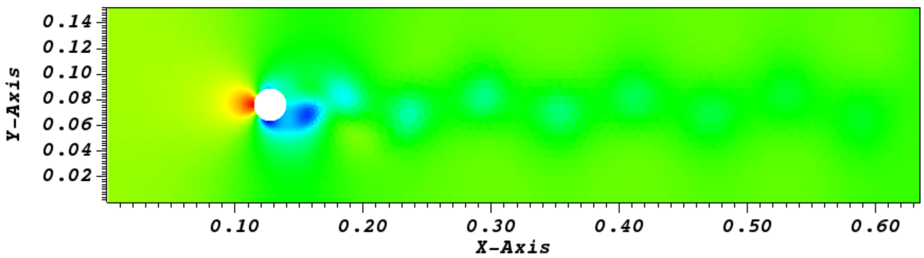
3.1 Velocity fields at t = 90s

We can see behind the cylinder the development of the Von karman vortices.



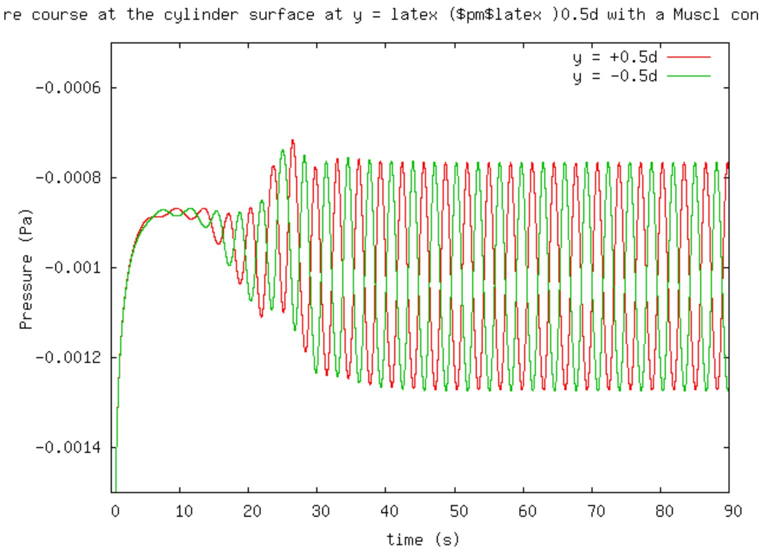
3.2 Velocity fields at t = 90s

We can see behind the cylinder the development of the Von karman vortices.

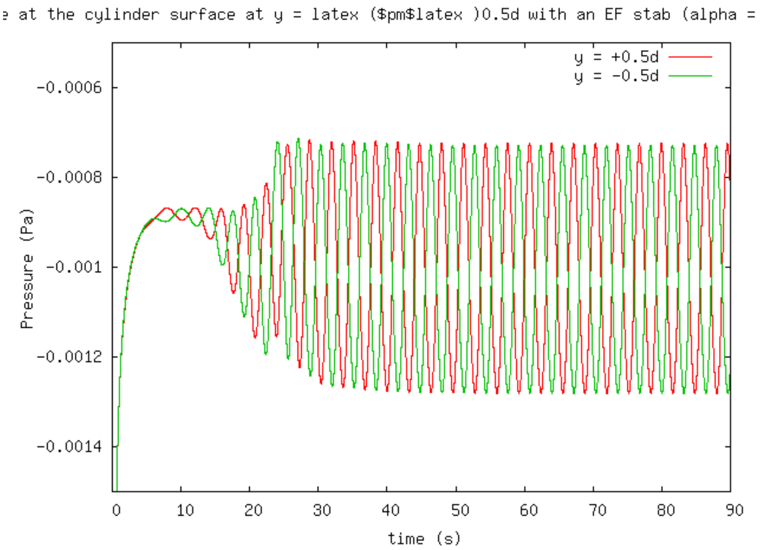


3.3 Pressure course at the cylinder surface at y = ± 0.5d with a Muscl convection scheme

It can be seen that the time of stabilization of the oscillations is of about 40s. From this instant, an oscillation frequency can be determined.

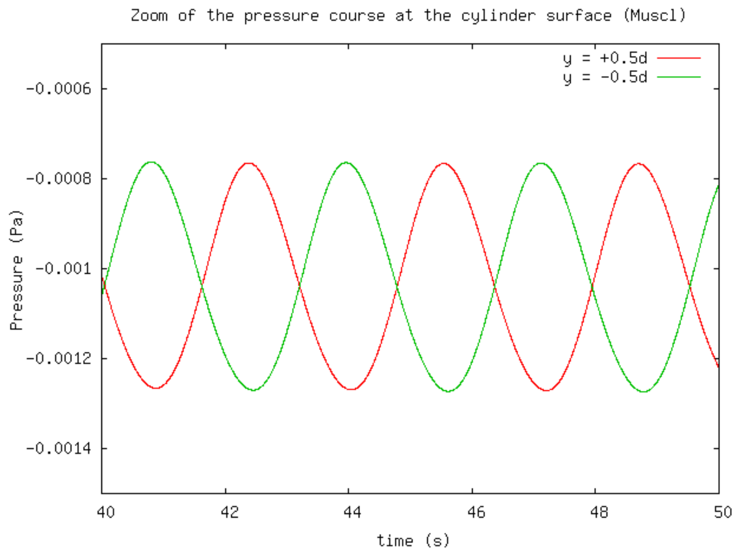


3.4 Pressure course at the cylinder surface at y = ±0.5d with an EF_stab (alpha = 0.2) convection scheme

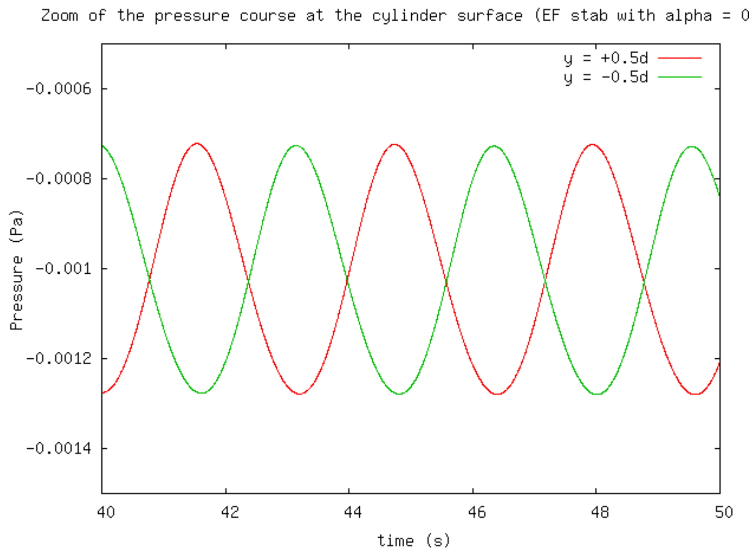


3.5 Zoom of the pressure course at the cylinder surface (Muscl)

Oscillations are well established in this time range



3.6 Zoom of the pressure course at the cylinder surface (EF_stab with alpha = 0.2)



3.7 Comparison of Strouhal numbers

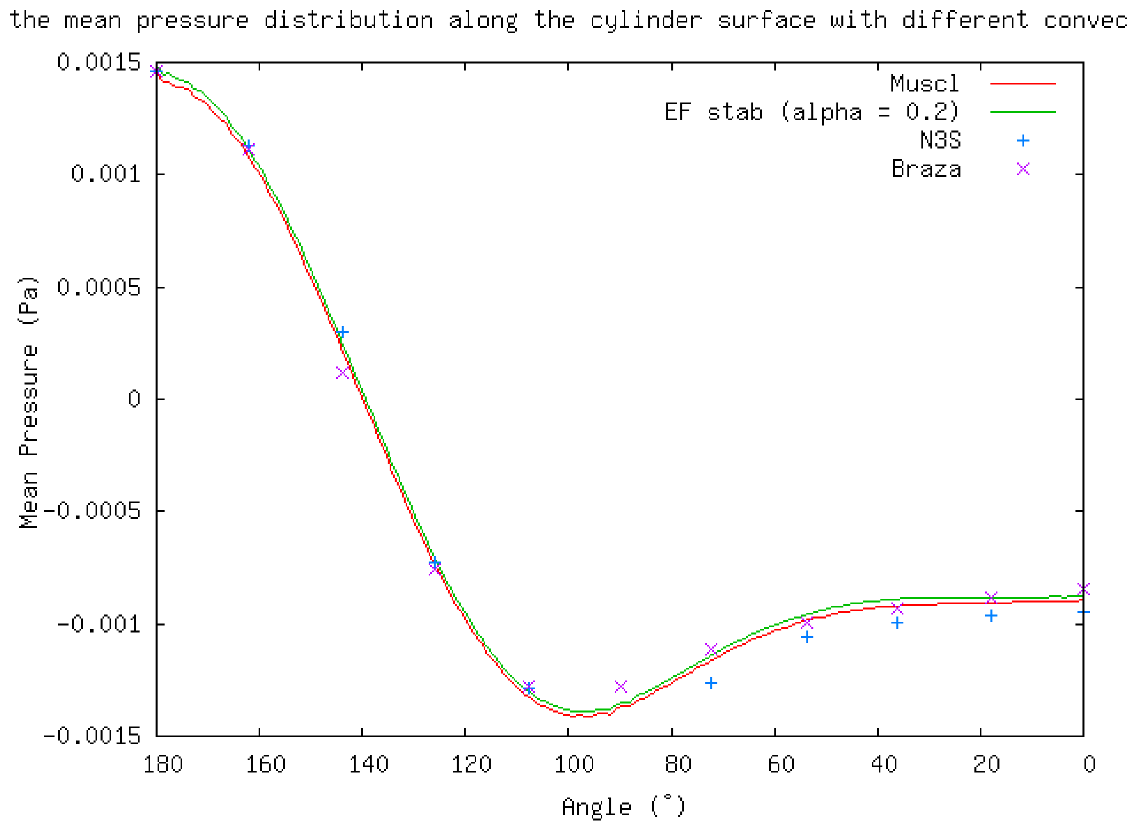
The temporal pressure course in the media allows the determination of the Strouhal number S_t defined as $S_t = \frac{f.d}{U}$, where f stands for the vortices emission frequency, U the undisturbed velocity (in our case the inlet velocity), and d the cylinder diameter. We can in this way compare the simulation values with those of Tritton and Roshko collected by Chabard [1]

	Frequency (Hz)	Stroual Number	Error % (Tritton)	Error % (Roshko)

	Frequency (Hz)	Stroual Number	Error % (Tritton)	Error % (Roshko)
Tritton	0.243	0.157	0	6
Roshko	0.259	0.167	6	0
Muscl	0.316	0.204	23.096	18.198
EF_stab (alpha = 0.2)	0.313	0.202	22.13	17.17

3.8 Comparison of the mean pressure distribution along the cylinder surface with different convection and time schemes

The distribution of the mean pressure along the cylinder surface (averaged from 40s up to 90s) is shown and compared to values of N3S [1] and Braza [2]



4 Conclusion

This simulation enables the validation of laminar calculations of an oscillating flow behind a cylinder with isothermal fluid and VEF grids. In this case, the calculated results are in good agreement with those obtained by Chabard [1] et Braza [2].

5 Recommendations for users

• The Euler implicite scheme is not recommanded because, as the calculation presents oscillations, the value of the facsec coefficient must remain small. The calculation time is then increased instead of being improved.
• The pressure variable to be employed in the data file is not 'Pression' but 'Pression_Pa', that gives the pressure in Pa.

6 Computer performance

	host	system	Total CPU Time	CPU time/step	number of cell
EI/Muscl/test	is241762.intra.cea.fr	Linux	3037.52	0.0900026	9668
EI/EF_stab02/test	is241762.intra.cea.fr	Linux	2810.67	0.0824376	9668
Total			5848.19		

7 Data Files

7.1 test

```
# Hydraulique 2D laminaire schema centre #
dimension 2
Pb_hydraulique pb
Domaine dom
# Read_file dom Cir_Cyl.geom  #
Read_file dom ../../geometry.geom
VEFPreP1B dis
Schema_Euler_Explicite sch
Read sch
{
  tinit 0.0
  tmax 90.0
  dt_min 1.e-6
  dt_max 1.e-1
  dt_impr 0.1
  dt_sauv 10.0
  seuil_statio 1.e-8
        facsec 1.
        diffusion_implicite 1
}
Fluide_Incompressible air
Read air
{
  mu  Champ_Uniforme 1 1.00e-5
  rho Champ_Uniforme 1 1.33
}
#
  nu = mu/rho = 7.518e-6
  Reynolds 100
#
Associate pb dom
Associate pb sch
Associate pb air
Discretize pb dis
      imprimer_flux dom { CERCLE }
Read pb
{
  Navier_Stokes_standard
  {
    solveur_pression Gcp { precond ssor { omega 1.6 }
                                        seuil 1.e-9
                                        impr
                                      }
    convection { muscl }
    diffusion { }
    conditions_initiales
    {
      vitesse Champ_Uniforme 2 0. 0.
    }
    boundary_conditions
```

```
    {
      CERCLE  paroi_fixe
      PAROI1  symetrie
      PAROI2  symetrie
      SORTIE  frontiere_ouverte_pression_imposee
                    Champ_Front_Uniforme 1 0.0
      ENTREE frontiere_ouverte_vitesse_imposee
                    Champ_front_Uniforme 2 0.03937 0.0
    }
  }
        Postraitement
  {
    Definition_champs {
      Pmoy Moyenne {
        t_deb 40 t_fin 89 source refChamp { Pb_champ pb Pression_Pa }
      }
    }
    Sondes
    {
      sonde_pression pression periode 1.e-6 points  4 0.1142 0.0762
                                                      0.1398 0.0762
                                                      0.1270 0.0890
                                                      0.1270 0.0634
      sonde_Pmoy1 Pmoy Periode 10 Circle 150 0.127 0.0762 0.0127 180 0
      sonde_Pmoy2 nodes Pmoy Periode 10 Circle 150 0.127 0.0762 0.0127 180 0
      sonde_Pmoy3 grav Pmoy Periode 10 Circle 150 0.127 0.0762 0.0127 180 0
              }
    Format lata
              Champs dt_post 30.0
    {
      pression som
                      Pression_Pa elem
      vitesse som
      vitesse elem
    }
       }
}
Solve pb
End
      sonde_Pmoy Pmoy Periode 10.5 Circle 150 0. 0. 0.0127 0 180
 reprise formatte ./sauv/circ_cyl_100_pb.sauv
imprimer_flux dom { CERCLE }
Cholesky { impr }
Gcp { precond ssor { omega 1.5 }
                                        seuil 1.e-14
                                        impr
                                      }
GCP_ssor { omega 1.65 seuil 1.e-6 impr }
```