2D flow around an oscillating cylinder - $Re_{H}= 185$

Numerical study based on the publication of Pham et al., Journal of Marine Science and Technology, Vol. 18, No. 3, pp. 361-368 (2010)
The motion of the cylinder is vertical and forced with a sinusoïdal function

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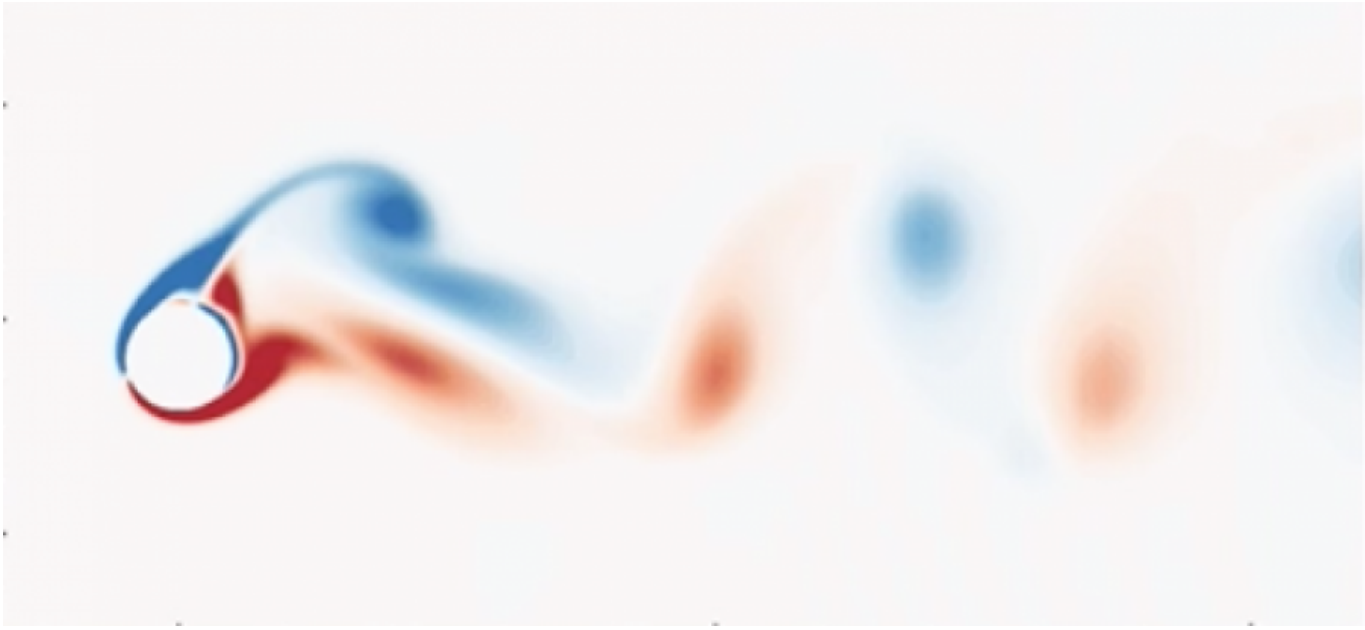
Simulation type : DNS (Sunfluidh code)
Location : /DATABASE_2DFLOW_AROUND_OSCILLATING_CYLINDER_DNS
Status : Free access



A video is available here

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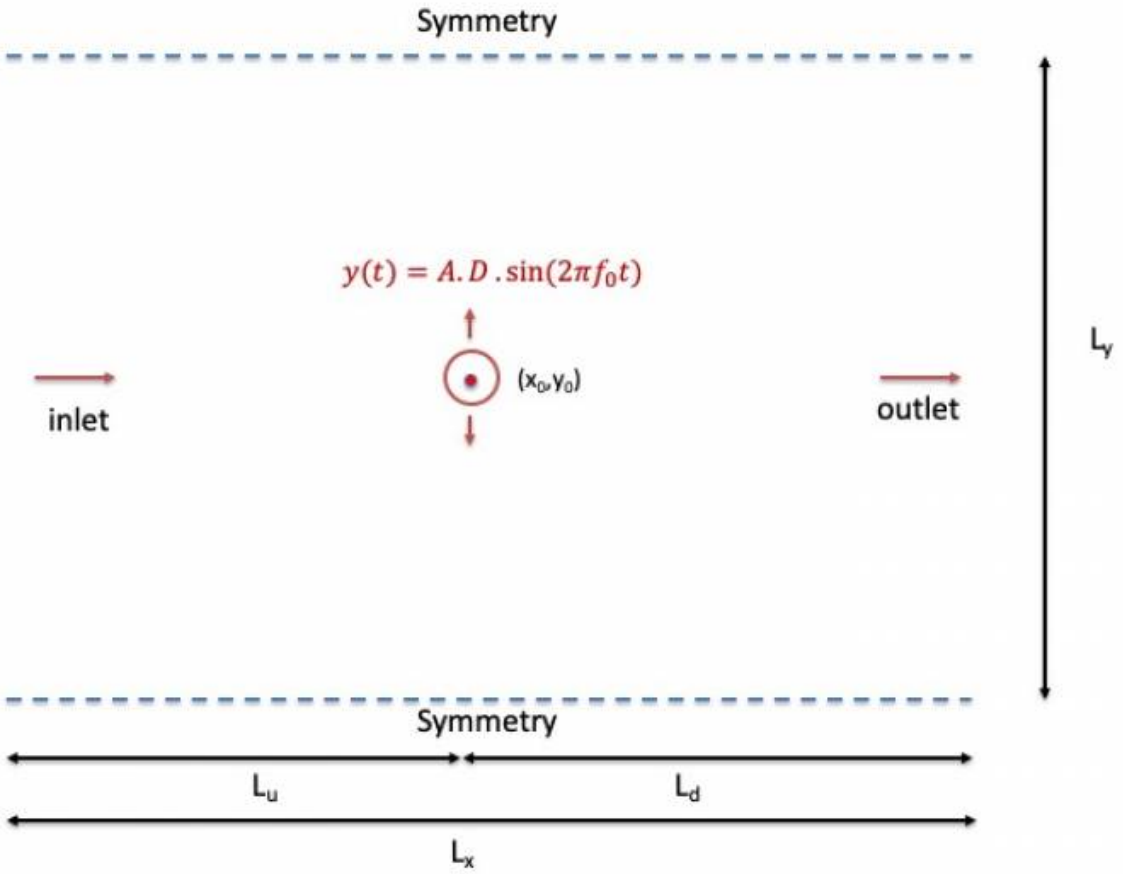
Simulation settings

2D sketch



Referential : cartesian geometry

1. axes :
    - x(i) : downstream direction
    - y(j) : normal direction
2. origin :
    - $x_0= 0$: centre of the cylinder
    - $y_0= 0$: mid-height

Reference scales

- Density : mass density of the fluid (ρ_0)
- Length : cylinder diameter (D)
- Velocity : velocity at inlet (U_0)
- Dynamic viscosity : dynamic viscosity of the fluid (μ_0)
- Reynolds number : $Re_H= \frac{\rho_0.U_0.D}{\mu_0}= 185$
- Strouhal number : $St_0=\frac{f}{f_0}$ (oscillating-cylinder frequency f over vortex-shedding frequency f_0 when the cylinder is at rest)
- motion magnitude : $A \times D$ (where A is the motion factor)

Non-dimensionalised data

- velocity : $U^*=\frac{U}{U_0}$
- density : $\rho^*= \rho/\rho_0= 1$
- coordinates : $x*=\frac{x}{D}$, $y^*=\frac{y}{D}$

Computational domain

1. **Domain scope**
    1. computational domain size
        - Downstream direction(x) : $L_x^*= 90.0$ (upward part $L_u= 40$, downward part $L_d=50$)
        - Normal direction (y) : $L_y^*= 80.0$
    2. Oscillating cylinder (vertical oscillating motion around the mid-height of the domain)
        - centre position at rest : $x_c= 0.0$ and $y_c= 0.0$
        - diameter: $D^*= 1$
        - oscillation frequency : $St= 0.95$ or $St= 1.2$
        - The cylinder is modeled with a pseudo-penalisation method (Pasquetti et al., Applied Numerical Mathematics, 2008)
2. **Boundary conditions**
    - Inlet : imposed pressure uniform velocity ($U_0=1$)
    - Outlet : Orlansky type
    - bottom and top conditions : symmetry
3. **Spatial resolution**
    - mesh size : $480 \times 480 $ (576.000 cells)
    - About cell-size
        - $\Delta x*$: from 0.0125 to $0.78785$$ (downstream direction)
        - $\Delta y*$: from 0.0125 to 0.65924 (normal direction)

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Data Recording : information about data types

- **Time series**
    - from probes
        - Physical quantities : velocity components along x and y directions (u,v) and pressure (p)
        - 1 probe
        - Time step= $2 \,10^{-2}$ time unit
        - Time range : 400 to 600 time units
        - Location : Xi= 3.5 , Xj=0.0
        - File name (per physical quantity): x_ins_00000.d with x= u,v,p
    - about cylinder motion
        - center position as a function of time (ASCII file ibm_position01.dat)
        - cylinder velocity as a function of time (ASCII file ibm_velocity01.dat)
        - global force components applied to the cylinder (ASCII file ibm_force01.dat)

        - force contributions exerted on the moving cylinder (ASCII file ibm_force_contribution01.dat, the four last columns can be ignored)
- **3D snapshots**
    - Instantaneous fields : velocity components in x, y and z directions (U,V), the pressure (P) and the phase function related to the body motion (TRACE)
    - Recording rate : 0.4 time unit
    - Time range from from 200.0 to 600.0 time units
    - File name : res_xxxxx_yyyyyyy.d
        - MPI subdomain ID: 0
        - Time ID : from 3 to 502

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Database organisation

Data size : ~ 7 Go
Main directory : /vol/DATABASE_MECA/DATABASE_2DFLOW_AROUND_OSCILLATING_CYLINDER_DNS
For more details about files, see the wiki doc of Sunfluidh

Intermediate directories (four cases of study)

- $St= 0.95$ and $A= 0.2$ - directory : CAS_F0.95_A0.2
- $St= 0.95$ and $A= 0.5$ - directory : CAS_F0.95_A0.5
- $St= 1.20$ and $A= 0.2$ - directory : CAS_F1.2_A0.2
- $St= 1.20$ and $A= 0.5$ - directory : CAS_F1.2_A0.5

Endpoint directories & files

```
  /DATASETUP       : ASCII files
                     input data file for sunfluidh : input3d.dat
  /GRID            : ASCII files
                     input data file         : data_meshgen.d
                     grid files for sunfluidh: maillx.d, mailly.d, maillz.d
  /SNAPSHOTS       : snapshots binary files res_xxxxx_yyyyyyy.d
  /TIMESERIES      : ASCII files
                     u_ins_00000.d , v_ins_00000.d and p_ins_00000.d
(timeseries of the velocity components and pressure from probe)
                     ibm_position01.dat, ibm_velocity01.dat (about cylinder
motion)
                     ibm_force01.dat, ibm_force_contribution01.dat (about
forces exerted on the cylinder)
```

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