

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 sinusoidal function

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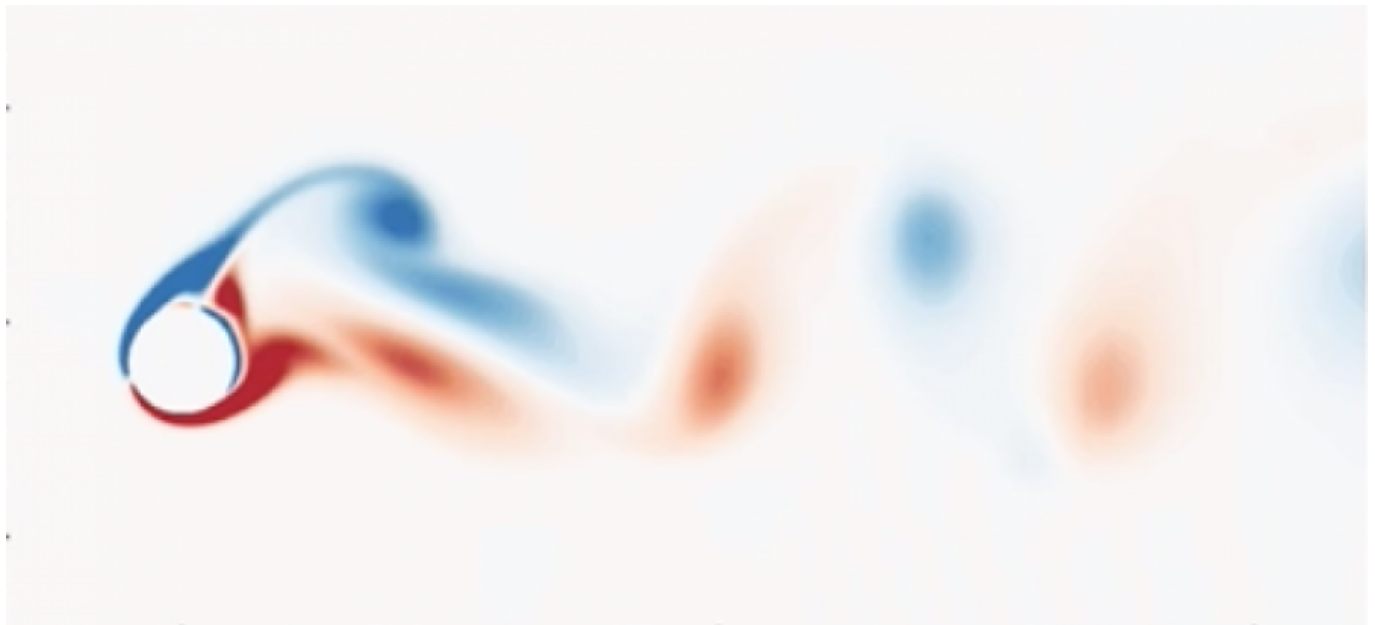
Date : July 2016

Simulation type : DNS (code Sunfluidh - [Sunfluidh code](#))

Location : /DATABASE_2DFLOW_AROUND_OSCILLATING_CYLINDER_DNS

Status : Free access for laboratory members, on request for external members

Data size : ~ 7 Gb

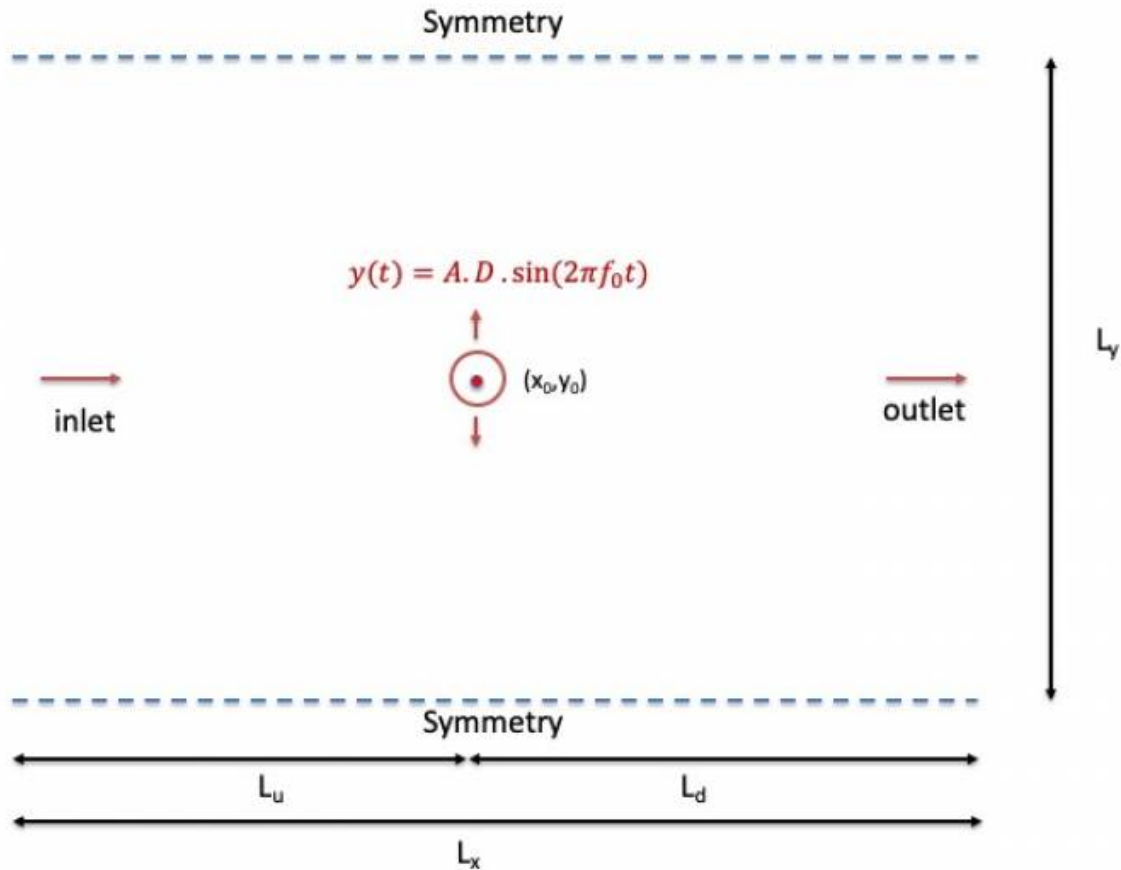


[A video is available here](#)

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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 : $\rho^* = \frac{\rho}{\rho_0} = 1$
- coordinates : $x^* = \frac{x}{D}$, $y^* = \frac{y}{D}$

Computational domain

1. Domain scope

- computational domain size
 - Downstream direction(x) : $L_x^* = 90.0$ (upward part $L_u = 40$, downward part $L_d = 50$)
 - Normal direction (y) : $L_y^* = 80.0$
- 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 : 480×480 (576.000 cells)
- About cell-size
 - Δx^* : from 0.0125 to 0.78785 (downstream direction)
 - Δy^* : from 0.0125 to 0.65924 (normal direction)

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Data features

• 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 : $X_i = 3.5$, $X_j = 0.0$
 - 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 Gb

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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