

2D flow around a heated square-cylinder - $Re_h = 50$, $Ra = 5 \times 10^6$



A heated square-cylinder is placed in a channel flow

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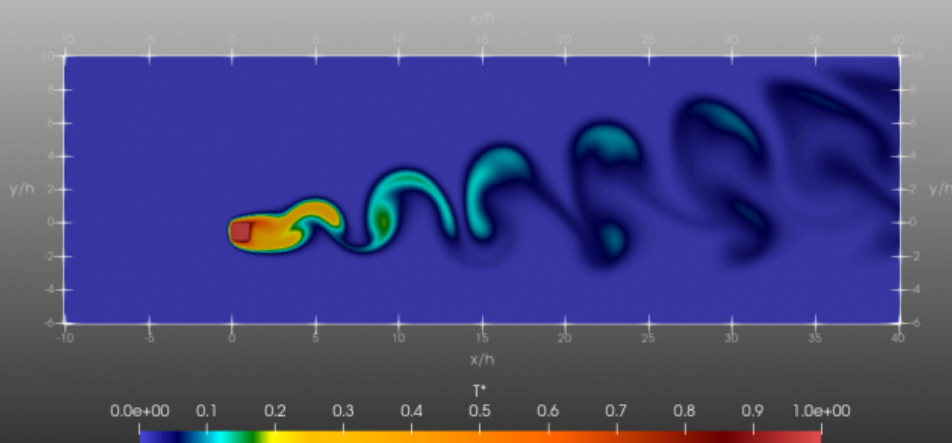
Date : June 2019

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

Location : /DATABASE_2DFLOW_AROUND_HEATED_SQUARECYLINDER_DNS

Status : Free access

Data size : ~ 3 Gb



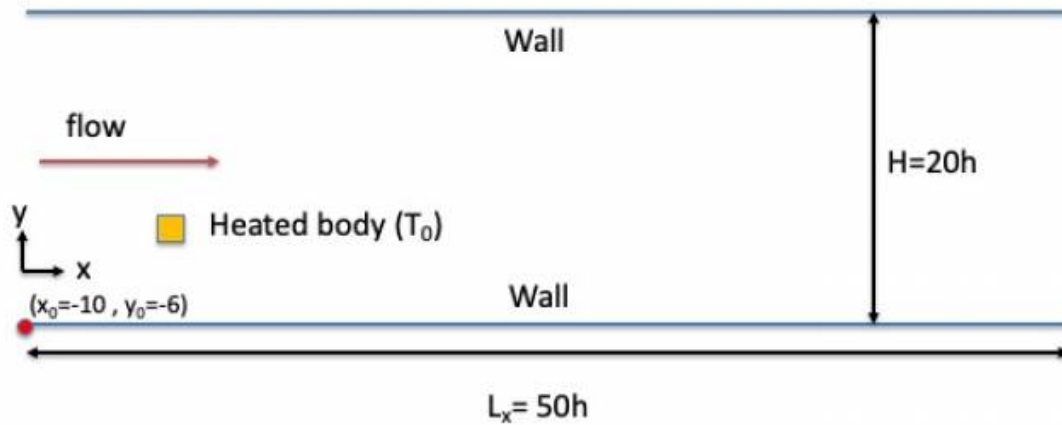
[A video is available here](#)

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Simulation settings

2D sketch

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Referential : cartesian geometry

1. axes :
 - $x(i)$: downstream direction
 - $y(j)$: normal direction
2. origin : lower left corner of the computational domain
 - $x_0= 10h$
 - $y_0= -6h$

Reference scales

- Density : mass density of the fluid (ρ_0)
- Lengths : cylinder size (h) and $H_u= 10h$ the distance between the domain's top and the square-cylinder's top.
- Velocity : velocity at inlet (U_0)
- Dynamic viscosity : dynamic viscosity of the fluid (μ_0)
- thermal diffusivity : (κ_0)
- Reynolds number : $Re_H= \frac{\rho_0.U_0.h}{\mu_0}= 50$
- Rayleigh number : $Ra= \frac{\rho_0.\beta.g\Delta T.H_u^3}{\mu_0 \kappa_0}= 5;10^6$

Non-dimensionalised data

- velocity : $U^* = \frac{U}{U_0}$
- density : $\rho^* = \frac{\rho}{\rho_0} = 1$
- coordinates : $x^* = \frac{x}{h}$, $y^* = \frac{y}{h}$
- temperature : $T^* = \frac{T - T_c}{T_h - T_c}$ (T_h and T_w are respectively the temperature imposed at the cylinder's walls and the temperature at the inlet and channel's walls)

Computational domain

1. Domain scope

- computational domain size (channel flow)
 - Downstream direction(x) : $L_x^* = 50.0$ (upward part $L_u = -10$, downward part $L_d = 40$)
 - Normal direction (y) : $L_y^* = 20.0$
- heated square cylinder
 - size: $h^* = 1$
 - temperature $T_h^* = 1$

1. Boundary conditions

- Inlet : imposed pressure uniform velocity ($U_0 = 1$)
- Outlet : Orlansky type
- Bottom and top conditions : walls at ($T_c^* = 0$)

2. Spatial resolution

- mesh size : 512×256 (131.072 cells)
- About cell-size
 - Δx^* : from 0.03125 to 0.723 (downstream direction)
 - Δy^* : from 0.03125 to 0.187 (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

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/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_000000.d , v_ins_000000.d and p_ins_000000.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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