Flow induced oscillation of a cylinder between two walls

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A cylinder is held by long thin threads in the gap between two parallel walls, so that it is free to move only in the direction perpendicular to the walls. A laminar steady flow (Poiseuille flow) is induced perpendicularly to it. Spontaneous regular oscillations of the cylinder are observed above a small threshold value of the Reynolds number ($Re = 15$). The frequency of the oscillating motion increases almost linearly with Re and the amplitude is limited by contacts with the walls.

In order to understand the influence of the confinement on the motion, $2D$ simulations using Freefem++ have been performed. The numerical method should provide a good fluid-structure coupling, a precise treatment of the constraints corresponding to the supporting threads, and an effective strategy to deal with the contact with walls.

The solid motion of the cylinder and the motion of the fluid (modelled by the Navier-Stokes equation) are included in the same variational formulation. This ensures that the momentum transfert between the fluid and the solid is accurate. The rigid motion of the cylinder is handled using a penalty method. The constraint of a motion only perpendicular to the walls is enforced by duality. The contact is handled by setting a (small) minimal distance between the cylinder and the wall. The gap can however be quite small. We track therefore the motion of the cylinder using an Arbitrary Lagrangian Eulerian method, in which the mesh deforms according to the position of the cylinder. This allows to maintain a precise description of the flow in the gap, even when it becomes small.

The obtained results are compared with experimental data.

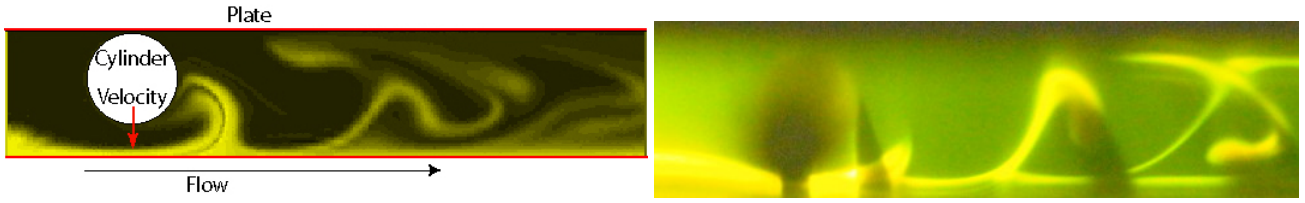

Figure 1: Numerical and experimental visualization (using dye) of the flow near the oscillating cylinder at Re=50.