FLUENT - Flow Past a Cylinder - Problem Specification

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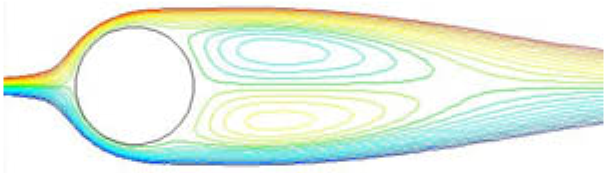
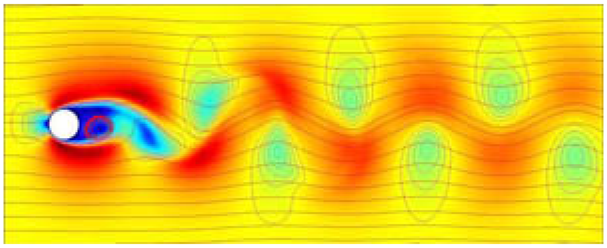
Problem Description



(a)



(b)

Figure 1. Two dimensional flow past a cylinder. (a) Steady flow; (b) Karman vortices.

Consider a uniform viscous fluid flow past an infinitely cylinder whose diameter is *d*. The Reynolds number *Re* is based on the incident velocity and cylinder diameter.

$$\mathrm{Re} \equiv \frac{\rho u d}{\mu}$$

where ρ is density, u is velocity magnitude, μ is the effective viscosity (laminar plus turbulent).

When Re is sufficiently low (less than 47), the flow is symmetric and steady, and a pair of vortices are formed behind the cylinder (Fig. 1a). When Re is higher than the critical value, the flow becomes unstable to the perturbations and leads to periodic Karman vortex shedding from the cylinder surface (Fig. 1b). When Re is higher than 180, the flow will become three-dimensional. 1

Flow past a cylinder is a simplified model problem to study the unsteady wake be hind a bluff body. In some real applications, the vortex shedding may cause the structure to vibrate, a phenomenon called flow-induced vibration, which could b e detrimental if the vortex shedding frequency happens to be close to the resonant frequency of the structure. In some other applications, the vortex shedding may cause noise, e.g., whining of the hanging wires in wind.

In this project, we perform 2D simulations at Reynolds numbers of 40, 300, and 1000, and compute the drag and lift coefficients for both steady and unsteady situations.

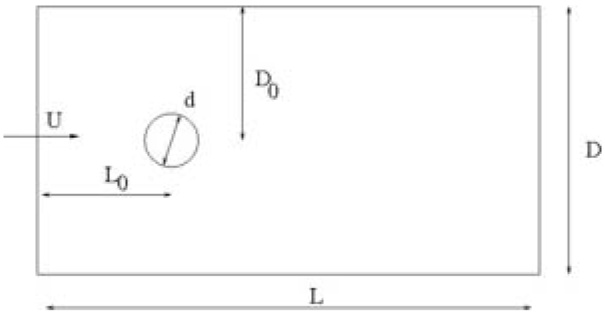


Figure 2. Computational domain.

h4. Computational Domain

A rectangular box is chosen as the computational domain, as shown in Fig. 2. Note that the flow is normalized by three repeating parameters: the density, free stream velocity, and the cylinder diameter. The only governing dimensionless parameter for the flow is the Reynolds number. Therefore, in Fluent we may simply set d = 1m, U = 1m/s, ρ = 1kg/m^3, and choose viscosity to match specified Re. The units for these parameters can be arbitrary as long as they are consistent and the desired Re is achieved. The results should also be presented in a nondimensional form, e.g., the normalized velocity, u/U, as a function of the normalized time, tU/d.

In this project, we will try different domain sizes to make sure the domain truncation does not introduce significant error.

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