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Excitation of Shear Layer Instability at Low Reynolds Number via an Unsteady Inflow

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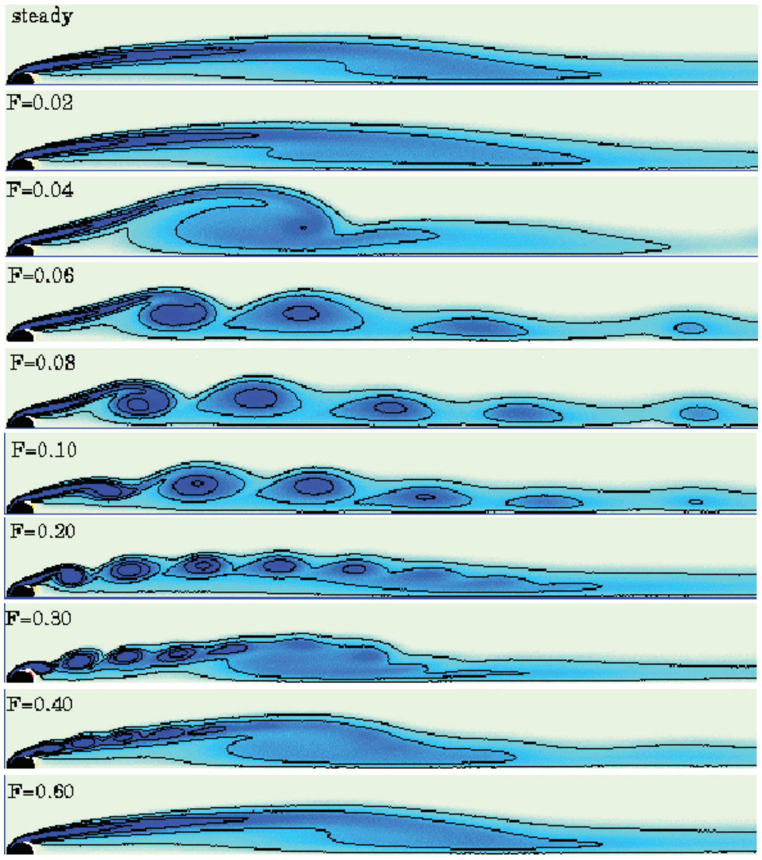

Fig. 1. *Re* = 300 flow past half a cylinder: vorticity fields for the fully developed flow for the steady inflow (top frame) and unsteady inflow for various F. The perturbation of the flow speed at the inlet is 1 % of the mean. Red color indicates counter-clockwise while the blue color shows clockwise vorticity.

The Reynolds number for the onset of the shear layer stability in the wake of the cylinder has been a topic of debate in the past. Here, we investigate the instability of the separated shear layer for the *Re* = 300 flow via an unsteady inflow: U_{mean} [1 + 0.01 sin(2πF t)]. To suppress the primary wake instability only one half of the flow past a cylinder is considered with symmetry boundary conditions at the wake center line. The flow with steady inflow is found to be stable (top frame of Fig. 1). The vorticity field for various values of non-dimensional frequency of the perturbation at the inlet, F, is shown in Fig 1. The shear layer instability is excited for a large range of F. While the vortices are large for low values of F they are smaller and spaced closer to each other for higher values of F. In all cases the dominant frequency of the unsteadiness corresponds to the excitation frequency. All these observations point to the shear layer instability being convective in nature. From the time histories of the oscillations in the flow in the wake it is observed that the instability is strongest for F~0.25. The computations have been carried out using a stabilized finite element formulation. The mesh consists of 99,014 nodes and 197,164 triangular elements. A stabilized finite element method has been utilized for computing the flow modeled by the incompressible Navier-Stokes equations.