A STUDY OF COUETTE FLOWS PAST A CIRCULAR CYLINDER

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The problem of flow past a circular cylinder has been a classical one. There have been many studies devoted to experimental observations and/or numerical investigations for flows with one or more lateral walls, e.g. [1-5]. Recently, vigorous investigations were carried out for asymmetry effect of cylinder setting on flow development [6-7]. Nevertheless, the shear effects due to the incoming flow on the flow development behind the cylinder have not been fully understood.

This study discusses some fundamental phenomena at low Reynolds numbers (*Re*) for a Couette flow past a circular cylinder which is arbitrarily placed in it. Both the recirculating flow and vortex shedding were investigated. In our study, a finite volume method with SIMPLE algorithm was employed to discretize the Navier-Stokes equations. For unsteady solutions, a second-order implicit time-marching scheme was employed. A series of careful computations were conducted to analyze flows with different blockage ratios, $B = d/w$, and asymmetry ratios, $R_a = 2a/w$, where d denotes the diameter of the cylinder, w the width between two plates, and a the distance of the cylinder center to the centerline of the flow field The parameter B varies from 0.1 to 0.5, and a varies at a multiple of 0.05 from 0 till the cylinder is very close to the moving wall. The onset Reynolds numbers for the attached recirculating region and the vortex shedding were computed for each case. The development of the recirculating flow and the characteristics of the vortex shedding were observed.

The computations show that when the Reynolds number is small, there exist one attached and one detached recirculating regions. It is interesting to find that the two regions can interchange for the same geometrical setting but at different Reynolds numbers. This feature has not been observed in other incoming flows. Furthermore, at higher Reynolds numbers, we compared the dynamics of vortex shedding phenomena for Couette, Poiseuille, and boundary layer flows, which may represent different shearing effects of the incoming flow.

References

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Keywords: shear effect, cylinder, vortex shedding