BIFURCATION OF FLOW AROUND A ROTATING DISK

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ABSTRACT: We investigate the flow around a rotating disk in a cylindrical casing. The thickness of the disk is finite and its radius is smaller than the inner radius of the casing (Fig. 1). Therefore, the flow field has an axial gap and the radial gap. This is more realistic model of fluid machinery than the flow field that has only an axial gap[1] or a rotating container[2]. Because the disk has a finite thickness, Taylor-Couette like flow appears at the radial gap[3]. The study is carried out by the direct numerical simulation based on the Navier-Stokes equations and the equation of continuity. Figure 2 shows the flow pattern shown from the axial direction. The rotation direction of the disk is counterclockwise. The Reynolds number Re is based on the disk radius and the rotating speed of the disk rim. When the Reynolds number is small, steady Taylor vortices appear at the radial gap (Fig. 2 (a)). At Re = 7000, six or seven vortices appear around the disk rim. These vortices make a time variation of torque acting on the disk. Therefore, this flow type is not preferable for the safety operation of fluid machinery. When the Reynolds number is 8000, small vortices appear around the disk rim. The number of the vortices is about 30. In this case, flow is stable and no variation of the torque appears. When the flow develops further and the Reynolds number is 12000, the vortices propagate into the inner region of the disk and they make a spiral rolls with negative front angle. As we have shown, at least four flow patterns are found. From a detail calculation, the critical Reynolds numbers among the appearances of the flow patterns in Fig. 2 are determined.

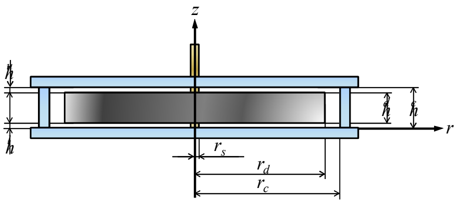
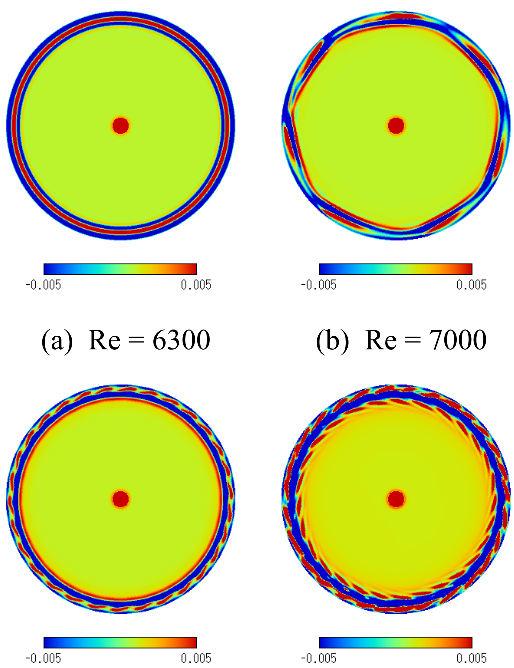


Fig.1 Configuration of flow field.



(a) Re = 6300 (b) Re = 7000

(c) Re = 8000 (d) Re = 12000

Fig. 2 Development of flows with Reynolds numbers.

References

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