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Numerical studies of viscous incompressible flow between two rotating concentric spheres. (English) Zbl 1121.76316

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Summary: The problem of determining the induced steady axially symmetric motion of an incompressible viscous fluid confined between two concentric spheres, with the outer sphere rotating with constant angular velocity and the inner sphere fixed, is numerically investigated for large Reynolds number. The governing Navier-Stokes equations expressed in terms of a stream function-vorticity formulation are reduced to a set of nonlinear ordinary differential equations in the radial variable, one of second order and the other of fourth order, by expanding the flow variables as an infinite series of orthogonal Gegenbauer functions. The numerical investigation is based on a finite-difference technique which does not involve iterations and which is valid for arbitrary large Reynolds number. Present calculations are performed for Reynolds numbers as large as 5000. The resulting flow patterns are displayed in the form of level curves. The results show a stable configuration consistent with experimental results with no evidence of any disjoint closed curves.

MSC:

76D05 Navier-Stokes equations for incompressible viscous fluids
76M20 Finite difference methods applied to problems in fluid mechanics
74H30 Regularity of solutions of dynamical problems in solid mechanics

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