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UNSTEADY INTRINSIC CONVECTION IN AN ANNULUS

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The problem of a viscous incompressible fluid motion driven by space-dependent body force has many applications in science and engineering. Examples of variable body forces include buoyancy force induced by a nonuniform temperature distribution and magnetic force. An interesting example is the sedimentation of spherical particles in a viscous fluid. The motion of N spherical particles in a viscous incompressible fluid which is bounded by a spherical container is considered in [1]. The authors found that there exists a convective flow in a homogeneous suspension where the fluid and the particles move together. This bulk fluid motion (called "intrinsic convection") is not buoyancy-driven since the suspension is homogeneous. A simpler model is adopted in [2] where the particles are replaced by point forces acting at their centers. The steady-state convection is calculated in a vertical channel bounded by two infinitely high parallel walls. The point sources in [2] are uniformly distributed across the layer. However, a layer free of particles (of the width comparable to the diameter of a particle) is assumed near each wall. The existence of intrinsic convection is verified in [3] experimentally.

Recently unsteady analytical solutions of viscous fluid flow with a variable body force in a vertical plane channel and infinite cylinder are found in [4], [5]. It is shown in [1] that the sedimentation velocity depends on the shape of the container. In the present paper we present an analytical solution of unsteady viscous fluid flow in a vertical annulus. The solution is obtained for an arbitrary body force which depends on the radial coordinate. The case of a body force which can be used to approximate intrinsic convection is analyzed in detail. Results of numerical calculations are presented.

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