SYNOPSIS

In engineering practice, the flows associated with rotating bodies are of great importance to the efficient operation of many devices of rotating machinery like electric motors, gas turbines and the electro-gyro. The study of a rotating disk is relevant to the problems of many rotating machines. The system consisting of one or two rotating disks is always a convenient means for studying viscous and turbulent motion of fluids because of its small power requirements. This model is used since a long time to study the fundamental aspects of boundary layer, stability and transport processes. Moreover, the rotating disk is one of a number of geometrical configurations of interest because many practical systems can be idealized in terms of a disk rotating in an infinite environment or in a housing.

The thesis deals with a few problems of fluid flows about rotating disks. It is divided into six chapters. In chapter I, a brief survey of literature mainly related to the thesis is given.

Chapter II contains the analysis of the unsteady laminar flow of a viscous incompressible fluid between two infinite parallel disks rotating with angular velocities varying with time. The deviations of the actual instantaneous state of the flow from the quasi-steady state are determined for cases in which (a) one disk rotates and the other is at rest, (b) both the disks rotate in opposite senses, and (c) both the disks rotate in the same sense. The results are illustrated for the angular velocity variation $\Omega = 100\,(1 - e^{-0.1t})$, where Ω is in rad./sec. and t is in seconds. For this type of variation, it is found that in all the three cases, the instantaneous shear stress and torque exceed their quasi-steady values.

In chapter III, the influence of suction and magnetic field on the torsional oscillations of an infinite plate in a viscous conducting fluid is discussed. The solution is obtained by expanding the velocity components and the pressure in terms of the amplitude of oscillation of the plate. For increasing values of the suction parameter and the Hartmann number, the steady components of radial and axial velocities decrease and the plane where the maximum value of radial velocity occurs shifts towards the plate. Due to suction and magnetic field, there is a decrease in the boundary layer thickness and the steady axial flow at infinity. Further, it is seen that the transverse shear stress has a phase lead over the oscillation of the plate and this lead is found to decrease with increasing values of the suction parameter and the Hartmann number. Finally, it is noticed that the radial shear stress is composed of a steady part and a fluctuating part, and is considerably affected by suction and magnetic field.

Chapter IV deals with the hydromagnetic stagnation flow against a porous rotating disk. It is assumed that the fluid is conducting, incompressible and viscous, and that the magnetic Prandtl number is small enough to justify neglecting induced fields. For small suction the equations of motion are integrated with the help of Kármán-Pohlhausen method, but for large suction a series solution in descending powers of the suction parameter is obtained. It is shown that the dimensionless moment coefficient increases and the boundary layer thickness and velocity profiles are considerably affected with the increase of suction and magnetic parameters. When the suction is large, the imposed magnetic field is seen to decrease the displacement and momentum thicknesses.

In chapter V, the problem of steady forced flow against a rotating disk is studied for an elastico-viscous liquid characterized by the constitutive equation due to Oldroyd (1958). The equations governing the flow are integrated by Kármán-Pohlhausen method. It is found that the flow behaviour depends strongly on the ratio between the velocity of the axial flow and the peripheral velocity of the disk. The effects of variation of this ratio on the boundary layer thickness and velocity profiles are qualitatively same as those for ordinary viscous liquids. Due to the elasticity of the liquid, there is a decrease in the radial shear stress and an increase in the dimensionless moment coefficient.

Chapter VI is devoted to the study of an elastico-viscous liquid between two infinite slowly rotating disks. The constitutive equation used is that proposed by Oldroyd (1958). A s in ordinary viscous liquids, the disks always experience attraction when they rotate in the same sense. However, when they rotate in opposite senses, the attraction changes over to repulsion provided the distance between the disks is decreased sifficiently. This repulsion is also found when one disk is rotating and the other is at rest. Finally, it is observed that the effects of elasticity are more pronounced when the disks rotate in opposite senses than when they rotate in the same sense.

The numerical computations involved in the thesis are performed using the IBM 1620 electronic digital computer at the Indian Institute of Technology, Kharagpur.

REFERENCE

J.G.Oldroyd (1958) Proc.Roy.Soc. London A, Vol.245, pp.278-297.