Abstract

This thesis deals with the unsteady flow behavior of some rate type fluids under different circumstances. Firstly, some basic definitions and concepts regarding fluid motion and methods to solve the flow problems have been discussed. Then the motion of ordinary Maxwell fluids and that of Oldroyd-B fluids with fractional derivatives over an infinite plate is studied.

In **chapter 2**, we have studied the unsteady motion of a Maxwell fluid over an infinite plate that applies an oscillating shear to the fluid which is the extension of some previously obtained results. After time $t = 0^+$ the fluid motion is produced by applying an oscillating shear. Fourier and Laplace transforms are used to find exact solutions that are presented as a sum of steady-state and transient solutions. They describe the motion of the fluid some time after its initiation. After that time, when the transients disappear, the motion of the fluid is described by the steady-state solutions that are periodic in time and independent of initial conditions. Finally, the time to reach the steady-state is determined. Similar solutions for Newtonian fluid are obtained as particular cases of general solutions by making $\lambda \to 0$.

The purpose of **chapter 3**, is to extend the first problem of Stokes to incompressible Oldroyd-B fluids with fractional derivatives. The Fourier sine and Laplace transforms are used. The solutions that have been obtained, are presented as a sum between the Newtonian solutions and non-Newtonian contributions. The non-Newtonian contributions, as expected, tend to zero for $\alpha = \beta$ and $\lambda \to \lambda_r$. Furthermore, the solutions for ordinary Oldroyd-B, fractional and ordinary Maxwell, fractional and ordinary second grade fluid, performing the same motion, are obtained as limiting cases of general solutions. The present solutions for ordinary Oldroyd-B and second grade fluids are verified by comparison with previously known results. Finally, the influence of material and fractional parameters on the fluid motion, as well as a comparison among fractional and Newtonian fluids, is analyzed by graphical illustrations.

In **chapter 4**, our concern is to study the velocity field corresponding to the Stokes' problems for fluids of Brinkman type. The solutions that have been obtained, are presented under suitable forms in terms of the classical solution of the first problem of Stokes for Newtonian fluids or as a sum between the steady-state and transient solutions. Furthermore, for $\alpha \to 0$ they are going to the well-known solutions for Newtonian fluids. The required time to reach the steady-state, as well as the temporal decay of the transients corresponding to the second problem of Stokes, has been determined by graphical illustrations.

The aim of **chapter 5**, is to establish exact and approximate expressions for dissipation, the power due to the shear stress at the wall and the boundary layer thickness corresponding to the motion of an Oldroyd-B fluid induced by a constantly accelerating plate. Similar expressions for Maxwell, second grade and Newtonian fluids, performing the same motion, are obtained as limiting cases of general results. Some specific features of the four modelss are emphasized by means of the asymptotic approximations.