SYNOPSIS

This thesis is devoted to the study of flow of certain non-Newtonian fluids. Three types of non-Newtonian fluids are considered, viz. - power-law fluids, second-order fluids and thermoviscous fluids. The whole thesis is divided into four chapters.

Chapter I is of review nature and contains a brief review of the previous results directly related to the present work.

Chapter II is devoted to the study of flows of power-law fluids. It is divided into two parts. In part one, the boundary layer equations in cylindrical coordinates are obtained. The necessary and sufficient conditions for the existence of similar solutions are then derived. It is shown that suitable similarity transformations can be found for (i) flow near an axially symmetric stagnation point, (ii) flow due to a rotating disk, (iii) flow of a rotating liquid over a disk which is either rotating or at rest, which reduce the partial differential equations of boundary layer to ordinary differential equations. As an example the problem of flow near an axially symmetric stagnation point has been completely solved by the momentum integral method. The most striking feature of the flow is that the boundary layer thickness is not constant as in the case of classical viscous fluids but

varies with x — the radial distance from the stagnation point. In part two of this chapter is discussed the problem of heat transfer in the entrance region for flow between two parallel plates. The velocity field is assumed to be fully developed. Viscous dissipation terms are included in the energy equation. It is found that the thermal entrance length required to attain the fully developed temperature field decreases as the flow behaviour index n , characterising the fluid, increases. In the fully developed region the rise in plate temperature increases as n increases.

Chapter III is devoted to the study of flow of second-order fluids past a cylinder. It is divided into two parts. In the first part steady flow past a symmetrical cylinder is considered. The Blasius method of series expansion of the stream function in terms of universal functions is used. These functions are then integrated by Kármán-Pohlhausen method. As a particular case the flow past a circular cylinder is considered in detail. The point on the cylinder where separation occurs is determined from the conditions that the shearing stress vanishes there. It is found that the increase in second-order effect shifts the point of separation towards the forward stagnation point. The second part of this chapter deals with the study of the boundary layer flow of second-order fluids around a periodically oscillating cylinder. The velocity field is obtained by a process of successive

approximations. The results are once again applied to the case of an oscillating circular cylinder and the stream lines of the secondary flow are drawn for various values of the parameter characterising the second-order fluids. It is found that in the region near the cylinder the stream lines of the secondary flow are closed loops while away from it they are U-shaped.

The last chapter is concerned with the study of the flow of certain thermoviscous fluids, the constitutive equations for which have been recently obtained by Koh and Eringen [1]. The boundary layer equations in two-dimensions for the flow of such fluids are obtained. As a particular case the problem of flow near a stagnation point is completely solved and the effect of material constant, characterising the fluid, on the Nusselt number at the plate and the temperature within the boundary layer is studied.

Reference

[1] Koh, S.L. and Eringen, A.C. (1963) Int.J.Engng.Sci., Vol.1, 199.