SYNOPSIS

In recent years, the problems of heat transfer have received considerable attention in connection with the motion of air-planes and missiles at high altitudes. The higher velocities with which air-drafts and space-vehicle move through the atmosphere, cause higher and higher temperatures in the boundary-layers surrounding such objects. Accordingly, special studies are recently made towards a clarification of the influence of ionization of the air-atoms on heat transfer. Also, the process of transpiration-cooling which is considered as an effective means to protect the surfaces of the space-crafts, has found a continuing interest. However, the heat exchange processes in the presence of heat generation or absorption, are still of increased interest, because of their varied applications in chemical processes associated with combustion and dissociation, in the re-entry problem of a space-ship and in the cooling of nuclear reactors.

The purpose of this thesis is to investigate the effect of the presence of heat sources or sinks on the heat transfer through porous boundaries.

In Chapter I of this thesis, we introduce the science of heat transfer with its manifold applications in several branches of engineering. After a brief survey of the literature of heat transfer, the basic equations of motion, energy for a viscous, electrically conducting liquid, are given and the present investigations made are discussed in detail.

In Chapter II, the heat transfer in the laminar flow between converging plane walls with and without heat sources has been analysed, using Ritz' variational method. The results obtained for the case with no heat sources are found in good agreement with those of Riley (1963). The rate of change of heat transfer is more pronounced in the presence of heat sources than in their absence.

In Chapter III, we have discussed the problem of heat transfer from a porous flat plate in the presence of constant heat sources. The cases of constant and variable fluid properties have been studied separately. The velocity and temperature distributions have been obtained, for large and small suction, with the help of successive approximation method and Ritz' method respectively. In the case of a solid (impervious) boundary, it is found that there exists, in the boundary layer, a certain region where the temperature is greater than that outside, while in the case of a porous boundary, no such region exists.

In Chapter IV, we have considered two cases, namely (a) the flow near a stagnation point with suction, and (b) the flow over a porous flat plate. The corresponding heat transfer problems in the presence of temperature-dependent heat sources have been discussed, in detail. In both the cases, (a) and (b), the effect of large suction has been studied with the help of perturbation method. To study the effect of small suction, we have employed the method of numerical integrations in the case (a) and the Ritz' method in the case (b). The results of case (a) have shown the existence of some situations wherein heat may flow from a body at lower temperature to one at higher temperature. From the results for case (b), the heat transfer parameter diminishes steadily, as the dimensionless longitudinal coordinate increases. This result is qualitatively different from the one for the case of constant heat sources.

In Chapter V, we have studied the convective hydromagnetic flow of a viscous electrically conducting liquid between porous parallel walls. We have assumed that the wall temperatures vary linearly along the lengths. The resulting non-linear boundary value problem has been solved by a suitable iterative procedure. The Nusselt numbers have been found to increase with the strength of the superposed magnetic field or the conductivity conditions at the walls. It has been noticed that suction reduces the viscous drag while injection enhances it.

In Chapter VI, we have considered the study of the rotationally symmetric flow and heat transfer of a non-Newtonian liquid in the presence of an infinite rotating disk. The results obtained for the flow have shown that the radial and circumferential components of shear stress and the dimensionless moment coefficient decrease as the ratio of the angular velocity of the disk to that of the fluid at infinity, increases. The heat transfer results have indicated that, for large values of the Prandtl number, there is heat flow to the disc or the fluid, according as the disk rotates faster or slower than the fluid at infinity, while for small values of the Prandtl number, heat flows always from the fluid to the disk.

The numerical computations contained in this thesis have been carried out on the Electronic Digital Computer, National Elliot 803, installed at the Hindusthan Air-Craft Limited, Bangalore, India.