ABSTRACT

Modeling and analysis of the dynamics of micropolar fluids has been the subject of many research papers in recent years. This stems from the fact that these types of fluids may have many engineering and industrial applications. Micropolar fluids are defined as fluids consisting of randomly oriented molecules whose fluid elements undergo translational as well as rotational motions. Analysis of physical problems using these types of fluids has revealed several interesting phenomena and microscopic effects arising from local structure and micro-rotation of fluid elements not found in Newtonian fluids. The theory is expected to provide a mathematical model for the non-Newtonian fluid behaviour observed in certain man-made liquids such as polymers, lubricants, fluids with additives, paints, animal blood and colloidal and suspension solutions, etc. The presence of dust or smoke, particularly in a gas, may also be modeled using micropolar fluid dynamics.

Many transport processes exist in nature and in industrial applications in which the simultaneous heat and mass transfer occur as a result of combined buoyancy effects of thermal diffusion and diffusion of chemical species. A few representative fields of interest in which combined heat and mass transfer plays an important role are designing of chemical processing equipment, formation and dispersion of fog, distribution of temperature and moisture over agricultural fields and groves of fruit trees, crop damage due to freezing, and environmental pollution.

The study of flow and heat transfer of an electrically conducting micropolar fluid past a porous plate under the influence of a magnetic field has attracted the interest of numerous researchers in view of its applications in many engineering problems, such as MHD generators, nuclear reactors, geothermal energy extractions and the boundary layer control in the field of aerodynamics. Keeping in mind some specific industrial applications such as polymer processing technology, numerous attempts have been made to analyze the effect of transverse magnetic field on boundary layer flow characteristics.

Radiative heat transfer flow is very important in manufacturing industries for the design of reliable equipments, nuclear plants, gas turbines and various propulsion devices for aircraft, missiles, satellites and space vehicles. Also, the

effects of thermal radiation on the forced and free convection flows are important in the context of space technology and processes involving high temperatures.

Also, the study of magnetohydrodynamic viscous radiate flows has important industrial, technological and geothermal applications such as high-temperature plasmas, cooling of nuclear reactors, liquid metal fluids, MHD accelerators, and power generation systems.

Hence, in this thesis an attempt is made to analyze the radiation and mass transfer effects on steady (or unsteady), two-dimensional, laminar, free (or mixed) convection flow of a micropolar fluid past a semi-infinite (or infinite) vertical porous plate through a porous or non Darcy porous medium with and without viscous dissipation, under varied initial and boundary conditions. The Rosseland approximation is used to describe radiative heat transfer in the limit of optically thick fluids. The governing equations of the flow field are coupled and non-linear. As exact solutions are not possible to such problems, approximate solutions are obtained using a regular perturbation method or Runge-Kutta fourth order technique with shooting method. The thesis is comprised of five chapters. The first three chapters deal with unsteady case whereas the remaining two chapters deal with steady case.

Part of the present thesis is published in the form papers in reputed scientific Journals.