ABSTRACT

The thesis deals with two types of problems, namely:

- Flow and heat transfer of a non-Newtonian fluid over a stretching sheet and
- Flow and heat transfer in a thin film of a Newtonian/non-Newtonian fluid over a stretching sheet.

The first type of problem concerns with the effects of variable fluid properties on a steady/unsteady MHD flow and heat transfer of non-Newtonian fluid over a stretching surface in the presence of a transverse magnetic field. The temperature-dependent fluid properties, namely, the fluid viscosity and the thermal conductivity are assumed to vary, respectively, as an inverse function and a linear function of temperature. Here the flow is influenced by linearly stretching the sheet in the presence of suction/ blowing and impermeability of the wall.

The second type of problem concerns with the flow and heat transfer in a thin film of a Ostwald-de Waele liquid over a horizontal stretching surface in the presence of a viscous dissipation under different physical situations. The effects of sundry parameter on the velocity, temperature, the skin friction, the wall temperature gradient, the film thickness are also discussed in this thesis.

The highlight of the thesis is to study the effect of non-dimensional parameters arising in the mathematical modeling of the industrial problem on the flow and heat transfer under different physical situations. The stretching sheet problems have many applications in the aerodynamic extrusion of plastic sheets, paper production, glass blowing, metal spinning, drawing plastic films, polymer devolatisation, bubble columns, fermentation, composite processing, boiling, plastic foam processing, bubble absorption and many others. The analytical/numerical results are compared with the results of earlier literature and they are found to be in very good agreement. With this motivation, the thesis is organized in to 9 chapters and they are described briefly as follows;

Chapter 1: is of introductory in nature and presents brief idea of fluids, types of fluids, boundary layer theory and its approximations. A literature survey

on Newtonian/non-Newtonian fluid flow over a stretching surface is under different physical situation is presented in detail.

In Chapter 2: exhibits the relevant basic constitute equations, various non-dimensional parameters relevant to the problems under the investigation, numerical method and nomenclature.

In Chapter 3: an analysis has been performed to study the flow and heat transfer characteristics of a non-Newtonian Ostwald-de Waele fluid flow over a non-linearly stretching surface in the presence of internal heat generation/ absorption. The stretching velocity and the prescribed surface temperature are assumed to vary with a power-law distance from the slit. Numerical solution is found to be dependent on six governing parameters, namely, the power law index, the velocity exponent parameter, the injection parameter, the temperature exponent parameter, the modified Prandtl number and the heat source/ sink parameter. The obtained numerical result shows that the injection parameter is to increase the velocity as well as the temperature and the suction parameter does the reverse and the temperature distribution is lower throughout the boundary layer for negative values of (heat sink) and higher for positive values of (heat source) as compared with the temperature profile in absence of heat source/ sink parameter.

Chapter 4: explores the effects of variable fluid properties on an unsteady MHD flow and heat transfer of a power law fluid over a stretching surface in the presence of a transverse magnetic field. The temperature-dependent fluid properties, namely, the fluid viscosity and the thermal conductivity are assumed to vary, respectively, as an inverse function and a linear function of temperature. The effect of various non-dimensional parameters are analyzed for velocity, temperature fields, skin friction and wall temperature gradient. The results obtained reveal many interesting behaviors that the effect of fluid viscosity parameter and magnetic parameter reduce the velocity boundary layer thickness, whereas enhance the thermal boundary layer thickness. This observation holds for all values of power law index. Further the effect of unsteady parameter is to reduce the velocity as well as thermal boundary layer thickness even in the presence/absence of variable fluid parameters. Of all the parameters, the variable thermo-physical property parameters have the strong effects on the skin friction heat transfer characteristics, the horizontal velocity and the temperature fields in the MHD flow of Ostwald–de Waele fluid over an unsteady stretching sheet.

Chapter 5: investigates numerically the combined buoyancy effects on the flow of a viscous, incompressible fluid over a vertical stretching surface in the presence of a chemical reaction. The model used for the Ostwald-de Waele fluid incorporates the effects of thermal conductivity as well as the mass diffusivity which are assumed to vary as linear functions of temperature and concentration respectively. The flow is caused solely by the linearly stretching of an elastic sheet and the reactive species is emitted from this sheet and undergoes an isothermal and homogeneous one-stage reaction as it diffuses into the surrounding fluid. The influences of sundry parameters on the velocity, temperature and the concentration fields are made and discussed in detail. Some of the findings can be summarized as follows: The influence of buoyancy parameters is to increase the velocity profile and decrease the temperature as well as the concentration profiles for all values of the power law index and the reaction rate parameter. An increase of the reaction rate parameter and wall concentration parameter reduces the thickness of the species distribution. This holds good for all values of the power-law index. An increase in the modified Grashoff number enhances the velocity boundary layer thickness; whereas quite the opposite is true for the mass concentration.

Chapter 6: investigates the problem of steady, laminar, two-dimensional boundary layer flow and heat transfer of an incompressible, viscous non-Newtonian fluid over a non-isothermal stretching sheet in the presence of viscous dissipation and internal heat generation/absorption. The non-Newtonian behavior of the fluid is characterized by the constitutive equation due to Powell and Eyring. A second order approximation of the Eyring Powell model is used to obtain the flow equations. Further, thermal conductivity is considered to vary linearly with temperature. Numerical computation has been carried out for two different cases, namely prescribed surface temperature (PST) and prescribed heat flux (PHF) to get the effect of non-Newtonian fluid parameters at various physical situations. The results obtained reveal many interesting behaviors that,

- The effect of increasing values of fluid material parameter λ is to decrease the skin friction as compared to Newtonian fluid and hence reduces the boundary layer thickness.

- The effect of fluid material parameter is to increase the wall temperature gradient in PST case and increase the wall temperature in PHF case and hence increases the thermal boundary thickness.
- The effect of increasing the value of heat source/sink parameter is to increase the temperature profile for both PST and PHF cases. However, minimum temperature distribution is observed in PHF case compared to PST case. This is true for all values of injection parameter.

The effects of variable thermal conductivity and thermal radiation on the MHD flow and heat transfer of a non-Newtonian power-law liquid film at a horizontal porous sheet in the presence of viscous dissipation is studied in **Chapter 7**. The governing time dependent boundary layer equations are transformed to coupled, non-linear ordinary differential equations with power-law index, unsteady parameter, film thickness, magnetic parameter, injection parameter, variable thermal conductivity parameter, thermal radiation parameter, the Prandtl number and the Eckert number. The results obtained reveal many interesting behaviors that the suction reduces the horizontal velocity boundary layer thickness whereas injection has quite the opposite effect on the velocity boundary layer. The effect of increasing S with different values of n, is to enhance the temperature, and hence increases the thermal boundary layer thickness. The effect of the variable thermal conductivity parameter, the Eckert number and the thermal radiation parameter is to increase the wall-temperature gradient; whereas the reverse trend is seen with increasing values of the Prandtl number.

Chapter 8: investigates, the effects of thermo-physical properties on the flow and heat transfer in a thin film of a power-law liquid over a horizontal stretching surface in the presence of a viscous dissipation. Temperature dependent fluid properties namely, the fluid viscosity and the fluid thermal conductivity are assumed to vary with temperature. The effects of unsteady parameter on the skin friction, the wall temperature gradient and the film thickness are presented and analyzed for zero and non-zero values of the temperature dependent thermo-physical properties. Some of the interesting results are as follows:

- The critical values of S_o are 1.3 when n = 0.8 and 3.0 when n = 1.2. This observation holds even the variable fluid properties are considered.

- The temperature distribution broadens when the power law index n decreases or when the unsteady parameter S increases.
- The dimensionless temperature within the fluid film decreases rapidly for higher values of the Prandtl number $\Pr$.

Chapter 9: an analysis has been carried out to study the heat transfer of a thin film base-fluid flow over an unsteady stretching surface. Here the base-fluid is assumed to be two component non- homogeneous equilibrium model for the transport phenomena which incorporates the effects of Brownian diffusion and thermophoresis. In addition to this, the fluid is considered to be non-Newtonian and comprises the behavior of shear thinning, Newtonian, and shear thickening fluids. The fluid properties namely the thermal conductivity and the mass diffusivity are varying linearly with temperature and species concentration respectively. The influences of nanofluid parameter on the velocity, temperature and the concentration fields are made and discussed in detail. In shear thinning fluids, viscosity is reduced with increasing shear rates; whereas for dilatants substances, viscosity increases with shear rate and becomes more viscous and will thicken with an increasing rate of shear. An increase in either parameters namely, the generalized Brownian motion parameter N_b and the generalized thermophoresis parameter N_t leads to a decrease the magnitude of the wall temperature gradient and hence increases the thermal boundary layer thickness. Increase in Lewis number Le is to decrease the Local Sherwood number i.e., reduces the nanoparticle concentration boundary layer thickness. The effect of variable species diffusivity parameter ε_1 is to increase the temperature profile which in turn increases the thermal boundary layer thickness and is true for all values of power-law index n.