Review of magneto-hydrodynamic flow, heat and mass transfer characteristics in a fluid

Parveen Kumar

Research Scholar, JJT University, Rajasthan

Abstract- In the present article I would like to stress on the potential research agenda for lasting reforms in the area of computational fluid dynamics. On the theoretical frameworks, I have tried to propose that a scope for lots of research is needed in this area of stretching sheet in fluid dynamics. On the basis of varied problem domains carried out in various researches in the past, I have proposed to divide this field into segments namely flow past a stretching sheet, magneto hydrodynamic flow, mixed convection flow and mass transfer flow. These areas have potential applications in industries which have made them important contributor for the progress of the society.

Index Terms- Stretching Sheet, Magneto Hydrodynamic, Mass Transfer, Convection

I. Theory

The study of laminar flow of a thin liquid film over a stretching sheet is currently attracting the attention of a growing number of researchers because of its immense potential to be used as a technological tool in many engineering applications, with applications in industries such as extrusion, melt-spinning etc. The pioneering works in this area has been done by crane in 1970 where he has explained the exact solution for a viscous and incompressible fluid in two dimensional steady flows in a stretching sheet over the application of uniform stress. Many researchers since then have contributed immensely in this stretching sheet area. Anderson (2002) has obtained the exact analytical solution for the slip-flow of a Newtonian fluid past a linearly stretched sheet. In 2003 Mahapatra and Gupta computed that a boundary layer is formed only when stretching velocity is less than the free stream velocity and an inverted boundary layer is formed when stretching velocity exceeds the free stream velocity. In 2008, Wang further extended stagnation flow to the three-dimensional case from the two-dimensional case. Jat and Chaudhary (2009) have studied the Stretching sheet with the conclusion that the velocity and temperature vary proportionally with the distance from stagnation point. Mehmood and Ali (2010) further investigated the heat transfer analysis in generalized three-dimensional channel flow of a stretching sheet. Y.Khan et.al (2012) used the homotopy analysis method first time for the unsteady linear viscoelastic fluid over a stretching/shrinking sheet with stagnation point flow. Rekha R. Rangi, Naseem Ahmad(2012) studied the boundary layer flow with variable thermal conductivity on a stretching cylinder and employed the Keller-box technique to solve out the non linear equations.

Kumari et al. (1990) investigated the impact of magnetic field on stretching sheet in an electrically conducting ambient fluid and observed various parameters like skin friction, induced magnetic field at the wall and the wall temperature. Andersson (1995) applied uniform magnetic field on stretching sheet and examined the complete similarity solution for the parameters like velocity and pressure in case of two dimensional Navier-Stokes equations. Mahapatra and Gupta (2001) studied the steady stagnation point flow over a flat deformable sheet in an incompressible, viscous, electrically conducting fluid. Ishak et al. (2008) while researching on electrically conducting fluid flow due to moving extensible sheet concluded that the effect of increase in magnetic parameter will reduce the velocity boundary layer thickness and on the other hand thermal boundary layer thickness increases. Ziya et al. (2008) and (2009a) studied inclined porous plate in the presence of high temperature and calculate the magneto-hydrodynamic free convection flow of a viscous fluid. Sharma and Singh (2009) have showed that in the presence of viscous dissipation and Ohmic heating fluid temperature increases while studying the effects of Ohmic heating and viscous dissipation of MHD flow on a stretching sheet. F. Labropulu (2011) examined the effect of transverse magnetic field on an infinite plate and studied the unsteady stagnation point flow of a Newtonian fluid and using finite difference technique, they found small and large frequencies of the oscillations for different values of the Hartmann's number. Stanford Shateyi **(**2013) studied the effect of MHD flow on a Maxwell fluid crossing the vertical stretching sheet in a Darcian porous medium.

In mixed (combined forced and free) convection the local heat transfer rate and local skin friction are the important parameter and can be modified in comparison to the pure forced convection. Due to the temperature difference, the buoyancy forces arise and they may assist or oppose the forced flow depending on the force flow direction and accordingly modifying the results in either increasing or decreasing the heat transfer rates. Chamkha (1998) has studied that on application of magnetic field on a Newtonian, electrically conducting and heat absorbing fluid at a stagnation point and concluded that local skin friction coefficient and the local Nusselt number vary proportionally in positive manner with increasing buoyancy effects for buoyancy assisting flows. Kumari (2001) has explained while studying the the effect of variable viscosity on free or mixed convection boundary that the constant viscosity has lesser heat transfer as compared to the variable velocity in fluids. Ishak et al. (2006b) while studying the steady mixed convection boundary layer flow in its own plane calculated the relation of variation of parameters like skin friction coefficient, local Nusselt number, Prandtl number. They observed that skin friction coefficient and local Nusselt number are directly proportional to the buoyancy parameter and on increase in Prandtl number,local Nusselt number increases but skin friction coefficient decreases. Prasad et al (2010) has observed that the momentum boundary layer as well as the thermal boundary layer thickness increases on increasing the variable viscosity parameter and the mixed convection parameter. D. Li et al (2011) investigated steady mixed convection flow of a viscoelastic fluid stagnating orthogonally on a heated or cooled vertical flat plate and found that the skin friction coefficient and the local heat transfer are inversely proportional to the Weissenberg number We in all the flow cases while the skin friction decreases with the Prandtl number Pr and the local heat transfer increases with the Prandtl number Pr .T. Hayat et al (2013) explained the heat transfer effects in magnetohydrodynamic (MHD) axisymmetric flow of third-grade fluid between the stretching sheets.

Takhar et al. (2000) observed the mass transfer characteristic on a viscous electrically conducting fluid and explained that the magnetic field reduces the surface mass transfer marginally but increases the surface skin friction significantly. Ghaly (2002) studied radiation effect on an isothermal sheet and found that velocity and temperature profiles, Nusselt number and local shear stress are markedly influenced by the radiation. Postelnicu (2007) while taking into consideration the diffusion-thermo (Dufour) and thermal-diffusion (Soret) effects explained that the order of chemical reaction and chemical reaction parameter play a vital role in the solution. Partha (2008) examined thermophoresis particle deposition in free convection on a vertical plate in non-Darcy porous medium and found that buoyancies are greatly influenced by the Soret effect. Pal (2009) investigated stretching sheet in the presence of buoyancy force and thermal radiation and found that the local Nusselt number is directly proportional to the Prandtl number. Postelnicu (2010) studied Dufour and Soret effect of stagnation flow in a porous medium and got the asymptotic analytical solution for large suction cases. M. Turkyilmazoglu & I. Pop (2013) has studied the flow and heat transfer of a Jeffrey fluid near the stagnation point on a stretching sheet and found that vaious physical parameters like, stretching/shrinking strength, Deborah number and suction/injection parameters affects the fluid flow while Prandtl number affects the temperature field.

II. Conclusion and Future Scope

This computational fluid dynamics area on stretching sheet is flourishing at a fast rate in various types of physical problems. Now a day various researchers are employing nanotechnology in fluids which can be looked upon in the future because nanotechnology enhances the thermal conductivity and various parameters which is of significant use. The scope for the future research could be the application of various soft computing techniques like genetic algorithm, fuzzy and neural network to solve out these physical problems which have enormous applications in the industry. Newer and newer techniques are emerging out to solve out the various stretching sheet problem which will be beneficial for industry and hence in long run to the society.

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AUTHORS

First Author – Parveen Kumar, Research Scholar, JJT University, Rajasthan