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CHEMICAL REACTION AND RADIATION EFFECTS ON MHD FLOW PAST AN EXPONENTIALLY STRETCHING SHEET WITH HEAT SINK

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ABSTRACT

The problem of heat and mass transfer of boundary layer flow over a stretching sheet have been applied in many manufacturing processes, especially the processes which involve chemical reaction. The study is an extension of the work done by Devi et al. (2014) where chemical reaction is added with reference to Seini and Makinde (2013). In this study, the problem of MHD boundary layer flow past an exponentially stretching sheet with chemical reaction and radiation effects with heat sink is studied. The governing system of partial differential equations is transformed into a system of ordinary differential equations. Then, the system is solved numerically by using Runge-Kutta-Fehlberg fourth fifth order (RKF45) method in MAPLE 15 software environment. The numerical results obtained are presented graphically for the velocity $f'(\eta)$, temperature $\theta(\eta)$ and concentration $\phi(\eta)$ profiles of the boundary layer. The effects of various parameters such as magnetic parameter M, Prandtl number Pr, heat generation parameter Q, Schmidt number Sc, radiation parameter R and reaction rate parameter β, on the profiles are studied and analysed. The numerical values for skin friction coefficient, local Nusselt number and local Sherwood number are tabulated and discussed. The study shows that various parameters give significant effect on the profiles of the fluid flow. It is observed that the reaction rate parameter affected the concentration profile significantly. It is found out that the concentration thickness of boundary layer decreases when reaction rate parameter increase.

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CHAPTER 1
INTRODUCTION

1.1 Background of Study

In 1904, the concept of boundary layers proposed by Ludwig Prandtl has revolutionised the understanding and analysis of fluid mechanics (Anderson Jr., 2005). Anderson Jr. (2005) also stated that the concept of boundary layer described in Ludwig's paper is that friction will cause the immediate fluid stick to the surface; followed by his assumption that there is no-slip condition on the surface and effects of frictional force were only found in a boundary layer, which is a thin region near the surface. Ludwig's finding is considered one of the important contributions to the field of fluid mechanics, for example, Prandtl's boundary layer concept is used in his theory of thin airfoil which made the practical calculation of airfoil properties possible (Anderson Jr., 1997).

Basically, the flow of boundary layer can be categorized into two types, which are laminar and turbulent (Blake, 1983). The laminar boundary layer is known by its smooth and steady flow and it is a very thin layer which forms due to a very small drag. Meanwhile, turbulent boundary layer is of type unsteady flow.

Magnetic fields influence many natural and forced flows, such as in the process of heating, pumping and stirring. Magnetohydrodynamic (MHD) is formally being related to the correlative interaction between fluid flow and magnetic fields, and the fluid must be an electrical conductor and has non-magnetic characteristics such as liquid metals, hot ionised gases (plasma) and strong electrolytes (Davidson, 2001). Davidson (2001) also stated that mutual interaction of a magnetic field and a velocity field is due to the laws of Faraday and Ampere, and also due to the Lorentz force experienced by a current-carrying body. The early development of MHD in engineering was done by J. Hartmann, in the 1960s. Hartmann invented the electromagnetic pump and also investigated the flow of mercury in homogeneous magnetic field theoretically and experimentally (Davidson, 2001). There are many applications of MHD boundary layer flow, for example in the modern metallurgical and metal-working process (Mukhopadhyay, 2013) and also in chemical engineering,