UNSTEADY MHD STAGNATION-POINT FLOW WITH HEAT AND MASS TRANSFER IN A MICROPOLAR FLUID IN THE PRESENCE OF THERMOPHORESIS AND SUCTION/INJECTION

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The effect of suction or injection on unsteady MHD flow with heat and mass transfer in a micropolar fluid near the forward stagnation point flow with thermophoresis has been investigated. The problem is reduced to a system of non-dimensional partial differential equations, which are solved numerically using the implicit finite-difference scheme. Profiles for velocity, microrotation, temperature and concentration as well as the skin friction, the rate of heat and mass transfer are determined and presented graphically for physical parameters. The results show that the suction increases the skin friction, the rate of heat and mass transfer while opposite trend is observed for the case of injection. It is also found that the effect of thermophoresis is decrease the concentration boundary layer thickness.

Key words: Unsteady; micropolar fluid; thermophoresis; suction/injection.
1. Introduction

The boundary layer flow with heat and mass transfer over a stretching surface is important in many industrial applications. A number of technical processes concerning polymers involve the cooling of continuous strips or filaments by drawing them through a quiescent fluid. Further, glass blowing, continuous casting of metals and spinning of fibres involve the flow due to a stretching surface. Crane [1] seemed to initiate the study of boundary layer flow due to a stretching surface in an otherwise ambient fluid. Thereafter, this problem has been studied extensively in various aspects in Newtonian fluids [2-5]. This type of problems was extended to non-Newtonian fluids. A micropolar fluid is a non-Newtonian fluid was first introduced by Eringen [6] which describes some microscopic effects arising from the local structure and micromotion of the fluid elements. The mathematical theory of equations of micropolar fluid and its application are presented by Lukaszewicz [7] and Ariman et al. [8, 9]. Kelson and Desseaux [10] studied micropolar flow over a stretching surface with uniform suction or blowing. Kelson and Farrell [11] investigated the effect of strong suction or injection in a micropolar fluid over a porous stretching sheet. Hiemenz [12] was the first to study two-dimensional stagnation flow using a similarity transform. Guram and Smith [13] studied the stagnation flow of micropolar fluids. Gorla [14] investigated the boundary layer flow at a stagnation point of a micropolar fluid by using similar method. Mahapatra and Gupta [15] analyzed MHD stagnation point flow towards a stretching sheet. Lok et al. [16] investigated the unsteady boundary layer flow at a stagnation point of a micropolar fluid of a plane surface. Xu et al. [17] considered the unsteady micropolar fluid near the forward stagnation point. Lok et al. [18] studied the unsteady stagnation point flow of a micropolar fluid with uniform suction or injection. Recently, Kumar et al. [19] studied the problem of heat transfer in a micropolar fluid toward a stagnation point flow over a stretching sheet.

Thermophoresis is a phenomenon by which submicron-sized particles suspended in a non-isothermal gas acquires a mean speed relative to the gas in the direction of decreasing temperature. It is a mechanism for the capture of particles on cold surfaces. It has many applications in aerosol technology, deposition of