SORET AND DUFOUR EFFECTS ON HEAT AND MASS TRANSFER DUE TO A STRETCHING CYLINDER SATURATED POROUS MEDIUM WITH CHEMICALLY-REACTIVE SPECIES

S. M. M. EL-KABEIR

Department of Mathematics, South Valley University, Faculty of Science, Aswan, Egypt. elkabeir@yahoo.com

***Abstract*— The diffusion-thermo and thermal-diffusion effects on heat and mass transfer by boundary layer flow over a stretching cylinder embedded in a porous medium have been studied numerically in the a presence of chemical reaction effect. The governing nonlinear partial differential equations are transformed into a set of coupled ordinary differential equations, which are solved numerically by using Runge-Kutta method with shooting techniques. Numerical results are obtained for the velocity, temperature and concentration distributions, as well as the skin friction coefficient, local Nusselt number and local Sherwood number for several values of the parameters, namely, the Reynolds number, Darcy number, chemical reaction parameter, Dufour and Soret numbers. The obtained results are presented graphically and the physical aspects of the problem are discussed.**

***Keywords*— Heat and Mass Transfer, Porous Medium, Stretching Cylinder, Dufour and Soret Effects, Chemical Reaction.**

I. INTRODUCTION

Convective flow through porous media has many important applications, such as heat transfer associated with heat recovery from geothermal systems and particularly in the field of large storage systems of agricultural products, heat transfer associated with storage of nuclear waste, exothermic reaction in packed reactors, heat removal from nuclear fuel debris, flows in soils, petroleum extraction, control of pollutant spread in groundwater, solar power collectors and porous material regenerative heat exchangers. Comprehensive reviews on this area have been made by many researchers such as Nield and Bejan (1999), Vafai (2000), and Ingham and Pop (1998 and 2002).

The combined heat and mass transfer problems with chemical reactions are of importance in many processes, and therefore have received a considerable amount of attention in recent years. In processes, such as drying, evaporation at the surface of a water body, energy transfer in a wet cooling tower and the flow in a desert cooler, the heat and mass transfer occurs simultaneously. Chemical reactions can be codified as either homogeneous or heterogeneous processes. A homogeneous reaction is one that occurs uniformly through a given phase. In contrast, a heterogeneous reaction takes place in a restricted region or within the boundary of a phase. A reaction is said to be the first order if the rate of reaction is directly proportional to the concentration itself. In many chemical engineering processes, a chemical reaction between a foreign mass and the fluid does occur. These processes take place in numerous industrial applications, such as the polymer production, the manufacturing of ceramics or glassware, the food processing and so on. The effects of chemical reaction and mass transfer on flow past an impulsively infinite vertical plate with constant heat flux were studied by Das *et al.* (1994). Andersson *et al.* (1994) have studied the flow and mass diffusion of a chemical species with first-order and higher order reactions over a linearly stretching surface. Anjalidevi and Kandasamy (1999) have analyzed the steady laminar flow along a semi-infinite horizontal plate in the presence of a species concentration and chemical reaction. Muthucumaraswamy (2002) has studied the effect of a chemical reaction on a moving isothermal vertical infinitely long surface with suction. Analytical solutions for the overall heat and mass transfer on MHD flow of a uniformly stretched vertical permeable surface with the effects of heat generation/absorption and chemical reaction were presented by Chamkha (2003). El-Kabeir and Modather (2007) studied the effect of chemical reaction on the heat and mass transfer by MHD flow over a vertical cone surface in micropolar fluids with heat generation/absorption. Rashad and El-Kabeir (2010) have studied the effects of thermal/mass diffusions and chemical reaction on the heat and mass transfer by unsteady mixed convection boundary layer past a vertical stretching sheet embedded in a porous medium. Rashad *et al.* (2011) studied the coupled heat and mass transfer by mixed convection about solid sphere saturated porous medium in the presence of chemical reaction effect and using Brinkman-Forchheimer extended Darcy model.

On other hand, Soret and Dufour effects are important for intermediate molecular weight gases in coupled heat and mass transfer in binary systems, often encountered in chemical process engineering. When species are introduced at a surface in a fluid domain, with a different (lower) density than the surrounding fluid, both Soret (thermo-diffusion) and Dufour (diffuso-thermal) effects can become influential. It is also found that the diffusion thermo effect is much stronger for injection of hydrogen and helium (molecular weight less than air) than for injection of argon, carbon dioxide, and xenon (molecular weight greater than air). It is observed, for a light gas such as helium or hydrogen is injected into the boundary layer, the temperature induced buoyancy