Buoyancy Effect on Stagnation Point Flow past a Stretching Vertical Surface with Newtonian Heating

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Abstract. In this study, the numerical investigations of the mixed convection on a stagnation point flow past a stretching vertical surface with Newtonian heating is considered. The non linear partial differential equations that governed the model are transformed by similarity variables before being solved numerically using the Keller-box method. The numerical solutions are obtained for the surface temperature, the heat transfer coefficient, the reduced skin friction coefficient and the reduced Nusselt number as well as the velocity and the temperature profiles. The features of the flow and heat transfer characteristics for pertinent parameters which are Prandtl number, stretching parameter, buoyancy parameter and conjugate parameter are analyzed and discussed.

Keywords: Newtonian heating; Stagnation point flow; Stretching vertical surface.
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INTRODUCTION

Mixed convection derived from the combination of the free and forced convection which occurred simultaneously. In mixed convection, the buoyancy parameter, λ take part as scalar to measure an influence of forced and free convection in a flow. Problems related to mixed convection boundary layer flows are widely applied onto many industrial outputs and engineering devices such as in electronic devices like computer power supply and also in an automotives engine cooling system as in car radiator.

Crane [1] was the first to study the convection boundary layer flow over a stretching sheet. Flow of a fluid past a stretching sheet is very important in extrusion processes and the sheeting production. The heat and mass transfer on a stretching sheet with suction or blowing was investigated by Gupta and Gupta [2]. They considered an isothermal moving plate and obtained the temperature and concentration distributions. In considering the study on stretching surface at the stagnation region, Ishak et al. [3, 4] investigated this topic with both vertical impermeable and permeable sheet. This type of problem was then extended to other type of fluid for example in a micropolar fluid, Maxwell fluid, viscoelastic fluid and nanofluid by many investigators by considering the usually applied boundary conditions, either prescribed wall temperature or prescribed wall heat flux.

Abbas et al. [5] studied the mixed convection on the stagnation point flow of a Maxwell fluid towards a vertical stretching surface while Ishak et al. [6] extended this topic with micropolar fluid. Recently, Mohamed et al. [7, 8] considered the stagnation point flow over a stretching surface in viscoelastic and nanofluid. Both studies considered the Walter's liquid-B model and Buongiorno-Darcy model, respectively.

On the other hand, Merkin [9] coined the Newtonian heating boundary conditions where the heat transfer at the surface is proportional to the local surface temperature. This type of boundary conditions is important in the development of thermal boundary layers in both fluid streams and axial wall conduction, which usually affects the heat exchanges performance has attracted many researchers investigated the Newtonian heating. Salleh et al. [10, 11] studied the forward stagnation point flow over a stretching sheet and the boundary layer flow over a stretching sheet with Newtonian heating. It is found that the increase of conjugate parameter for the Newtonian heating enhanced both surface temperature and the heat transfer coefficient. Other related papers included from the works by