*MATTER: International Journal of Science and Technology*
*ISSN 2454-5880*

*Arifin et al., 2017*

*Volume 3 Issue 2, pp. 525- 532*

*Date of Publication: 9th November 2017*

*DOI-https://dx.doi.org/10.20319/mijst.2017.32.525532*

*This paper can be cited as: Arifin, N., Yusof, S., & Ismail, N. (2017). Slip Effects on MHD Stagnation-Point Flow of Carreau Fluid Past A Permeable Shrinking Sheet. MATTER: International Journal of Science and Technology, 3(2), 525-532.*



# SLIP EFFECTS ON MHD STAGNATION-POINT FLOW OF CARREAU FLUID PAST A PERMEABLE SHRINKING SHEET

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## Abstract

*Carreau fluid is a type of generalized Newtonian fluid where viscosity depends upon the shear rate of the fluid and then uses it to obtain a formulation for the boundary layer equations of the Carreau fluid. The objective of the present study is to analyze the development of the slip effect on the MHD stagnation-point flow of Carreau fluid past a shrinking sheet. The mathematical modeling of Carreau fluid has been developed for boundary layer problem and the governing partial differential equations are transformed into ordinary differential equation using self-similarity transformation. The effect of velocity slip is taken into account and controlled by non-dimensional parameter. The*

*dual solutions are obtained when the sheet is shrunk. The study shows that the skin friction decreases with an increase in velocity slip.*

**Keywords**

Carreau Fluid, Boundary Layer, Shrinking Sheet, Slip Condition

## 1. Introduction

The study on the heat and mass transfer characteristics about convection of non-Newtonian fluids is of much importance because of practical engineering applications, such as catalytic reactors (Cohen & Maron, 1983), the filtration devices (Holeschovsky & Cooney, 1991) and blood plasmaphosresis devices (Beaudoin & Jaffrin, 1989). The convective heat transfer mechanisms of non-Newtonian fluids are the subject of considerable works and are well understood today. The Carreau viscosity model is one of the non-Newtonian fluid model in which constitutive relationship is valid for low and high shear rates. The peristaltic transport of Carreau fluid in an asymmetric channel has been analyzed by Ali & Hayat (2007). The flow of Carreus fluid down an incline free surface was examined by Tshehla (2011). In another article, Olajuwon (2011) studied convective heat mass transfer in a hydromagnetic flow Carreau fluid past a vertical porous plat in presence of thermal radiation and thermal diffusion. Later, Hayat et al. (2014) discussed boundary layer flow of Carreau fluid over a convectively heated stretching sheet. Akhbar et al. (2014) analyzed MHD stagnation point flow of Carreau fluid toward a permeable shrinking sheet and they obtained the dual solution. Naganthran & Nazar (2016) extended Akhbar et al. (2014) paper to analyze the stability of dual solution and they showed that the first solution is stable and the second solution is unstable. Very recently, Azam et al. (2017) investigated the unsteady magnetohydrodynamic (MHD) axisymmetric flow of Carreau nanofluid over a radially stretching sheet. It should be mentioned that the present work is to extend paper by Akhbar et al. (2014) on MHD stagnation point flow of Carreau fluid toward a permeable shrinking sheet with slip condition.

## 2. Problem Formulation

Consider the steady two-dimensional flow of a Carreau fluid near the stagnation-point on a vertical flat plate of uniform ambient temperature $T_\infty$. It is assumed that the velocity distribution far