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Exploring the Cattaneo-Christov heat flux phenomenon on a Maxwell-type nanofluid coexisting with homogeneous/heterogeneous reactions

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Abstract. This specific article unfolds the efficacy of Cattaneo-Christov heat flux on the heat and mass transport of Maxwell nanofluid flow over a stretched sheet with changeable thickness. Homogeneous/heterogeneous reactions in the fluid are additionally considered. The Cattaneo-Christov heat flux model is initiated in the energy equation. Appropriate similarity transformations are taken up to form a system of nonlinear ODEs. The impact of related parameters on the nanoparticle concentration and temperature is inspected through tables and diagrams. It is renowned that temperature distribution increases for lower values of the thermal relaxation parameter. The rate of mass transfer is enhanced for increasing in the heterogeneous reaction parameter but the reverse tendency is ensued for the homogeneous reaction parameter. On the other side, the rate of heat transfer is getting enhanced for the Cattaneo-Christov model compared to the classical Fourier's model for some flow factors. Thus the implication of the current study is to delve its unique effort towards the generalized version of traditional Fourier's law at nano level.

1 Introduction

In recent years, many research workers have had a great interest to examine carefully the behaviours and nitty-gritty of non-Newtonian fluids whose viscosity is based on shear rate. Various applications of these category fluids in fiber industry, cosmetics industry, chemical engineering etc. have caused such inspiration. Almost all the stuffs such as tooth pest, blood, ketchup, shampoo, custard, starch, paint etc. are an example of this type of fluids. Beside these, engineers and mathematicians face great confront to non-Newtonian fluids as the Navier-Stokes theory is insufficient for such fluids and one cannot find a single nature constitutive equation which manifests all the properties (shear-thinning and shear-thickening; visco-elasticity and visco-plasticity) of such fluids. However, under the scope of the implementation of such fluids in practical situations, many authors carefully initiate a number of mathematical models [1–5]. Ashraf *et al.* [6] discussed Maxwell-type fluid flow persuaded by a stretched sheet. Considering the effects for fractional magnetohydrodynamic Maxwell fluid, Zhao *et al.* [7] scrutinized transport properties in an absorbent medium. Mabood *et al.* [8] explored the shock of magnetic field on radiative fluid flow. Today, researchers are significantly attracted by the rheological models of a nanofluid in the study of flow problems by treating the nanofluid as a non-Newtonian. Gorla *et al.* [9] transact with the convective transport of a micropolar-type nanofluid over a stretched surface. Sun and Zhang [10] used single phase nanofluid and argued the flow model in a micro planer unexpected expansion. Macha *et al.* [11] deeply investigated the magnetohydrodynamic power-law–type nanofluid. Similar explorations can be instituted in [12–15].

Almost two centuries have passed since the implementation of the theory of heat conduction has been built-up a lot in nuclear reactors, electronics, cooling technology, engineering phenomena etc. But the law has a major drawback. In fact, the Fourier heat expression provides parabolic energy equation which exhibits that the whole system is instantly influenced by the primary disturbance. This observable fact is named as "paradox of heat conduction". In order to

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