



Cattaneo-Christov Heat Flux in EMHD Flow of a Chemically Reacting Casson Fluid over a Riga Plate with Activation Energy

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ABSTRACT: This paper investigates the magnetohydrodynamic (MHD) flow and heat transfer characteristics of a non-Newtonian Casson fluid over a Riga plate. The Riga plate, an electromagnetic actuator consisting of alternating permanent magnets and electrodes, is employed to generate a wall-parallel Lorentz force that assists the flow. The mathematical model incorporates the Cattaneo-Christov heat flux theory to account for thermal relaxation time, offering a more realistic perspective than the classical Fourier law. Additionally, the mass transport phenomenon is analyzed in the presence of Activation Energy and binary chemical reaction. The governing partial differential equations are transformed into a system of nonlinear ordinary differential equations using suitable similarity transformations and solved numerically using the `bvp4c` collocation method in MATLAB. The code is validated against limiting cases in the existing literature, showing excellent agreement. The impact of pertinent parameters such as the modified Hartmann number (Q), Casson fluid parameter (β), thermal relaxation parameter (δ_T), and activation energy (E) on the flow fields is visualized and discussed. The results indicate that the Riga plate significantly enhances the velocity profile and skin friction coefficient, thereby delaying boundary layer separation. Furthermore, the fluid temperature is found to decrease with an increase in the thermal relaxation parameter. An entropy generation analysis is also performed, revealing that the primary sources of irreversibility are the electromagnetic forces and fluid friction near the wall.

Keywords: Casson fluid, Riga plate, Cattaneo-Christov heat flux, activation energy, entropy generation, chemical reaction.

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Nomenclature

Symbol	Description
Roman Symbols	
a	Width of magnets and electrodes [m]
B_0	Magnetic field strength [Tesla]
C	Species concentration [mol m ⁻³]
C_p	Specific heat at constant pressure [J kg ⁻¹ K ⁻¹]
C_f	Skin friction coefficient