Impact of Hall Current on the Entropy Generation of Radiative MHD Mixed Convection Casson Fluid

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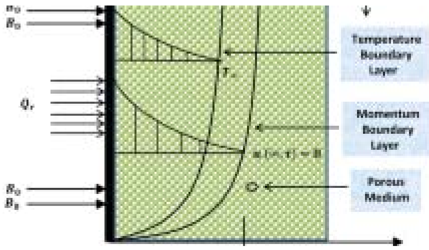
Abstract

One of the fundamental problems in engineering processes is the efficient utilization of energy during convection in fluid flow. Studies show that entropy generation exists for all fluid transfer processes and entropy generation destroys useful energy. Furthermore, it has been discovered that some pertinent flow parameters might be chosen in order to minimize entropy generation inside the system. In view of this, the fully developed electrically conducting free convection Casson fluid flow formed by two infinite vertical parallel plates with thermal radiation, Hall current and rotation effects is investigated. The governing equations have been obtained and transformed by suitable transformation variables. Semi-analytical solutions via differential transform technique are obtained using relevant boundary conditions. The results are utilized to calculate fluid irreversibility and Bejan number. The impacts of Hall parameter, rotation parameter, thermal radiation, Casson parameter, Hartman number, Schmidt number and chemical reaction together with skin friction, Nusselt number and Sherwood number are discussed and presented via plots and tables. Generally, entropy generation is discouraged at the upper walls of the channel with higher values of Casson parameter, Schimdt number and chemical reaction parameter while Hall current parameter boost entropy generation in the entire flow channel. Furthermore, Heat transfer irreversibility dominates entropy generation due to a rise in the values of chemical reaction parameter and Schmidt number.



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Article Open access19 February 2021

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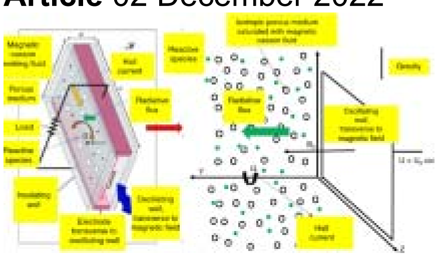
Article 02 December 2022



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Article 29 May 2024

Abbreviations

***u,v,w*:**
Velocity component along x,y,z-directions

***g^{*}*:**
Acceleration due to gravity

***k*:**
Thermal conductivity

$\Pr$:
Prandtl number

B_{0} :
Magnetic parameter

H^{2} :
Hartman number

T_{1} ,T_{2} :
Fluid temperatures at left and right plates respectively

C_{1} ,C_{2} :
Fluid concentrations at left and right plates respectively

S_{g} :
Characteristic entropy generation

Ns :
Dimensionless entropy generation

Ra :
Thermal radiation parameter

R^{2} :
Rotation parameter

Br :
Brinkman number

Gr :
Local Grashof number due to temperature differences

Gc :
Local Grashof number due to concentration differences

Sc :
Schmidt number

m :
Hall current parameter

C_{p} :
Specific heat at constant pressure

kf :
Chemical reaction parameter

q_{r} :
Radiative heat flux

D :
Mass diffusivity

T :
Fluid temperature

C :
Concentration

k^{c} :
Rosseland mean absorption coefficient

β :
Casson parameter

β^{*} :
Coefficient of thermal expansion

β^{c} :
Coefficient of expansion with concentration

μ :
Dynamic viscosity

ν :
Kinematic viscosity

σ :
Electrical conductivity

θ :
Dimensionless temperature

ϕ :
Dimensionless concentration

ψ :
Stream function

η :
Similarity variable

ρ :
Fluid density

α :
Thermal diffusivity

$\varOmega$:
Dimensionless temperature difference

$\varOmega^{*}$:
Angular velocity

σ^{c} :
Stefan–Boltzmann constant

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