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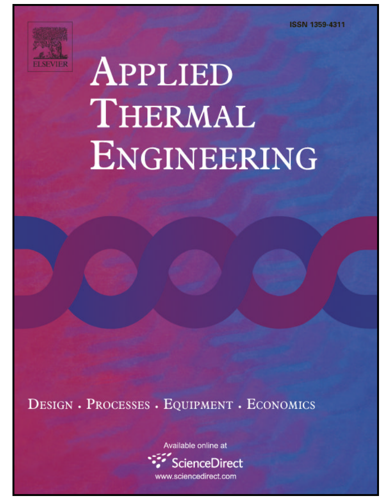

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Seyed Saeed Mousavi Golsefid, Nima Amanifard, Hamed Mohaddes Deylami, Farid Dolati

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Numerical and experimental study on EHD heat transfer enhancement with Joule heating effect through a rectangular enclosure

Seyed Saeed Mousavi Golsefid [a], Nima Amanifard[a], Hamed Mohaddes Deylami[b], Farid Dolati[a]
[a]Mechanical Engineering Department, Faculty of Engineering, University of Guilan, Rasht, Iran;
[b]Faculty of Technology and Engineering, East of Guilan, University of Guilan, Rudsar, Iran
[*]Corresponding author. Tel.: +98-131-6690270; Fax: +98-131-6690271
Email address: namanif@guilan.ac.ir; nima.amanifard@gmail.com

Abstract

The objective of this study is to determine the best electrodes configuration for increasing heat transfer in a rectangular enclosure. Numerical simulations are obtained using finite volume method. Experiments were also performed for heat transfer analysis and the results were compared with the numerical predictions. In addition, the Joule heating is added in governing equations to show its dominance effect in low Rayleigh numbers. The result shows a significant effect of the electrodes arrangement on the heat transfer rate and power consumption.

Keywords: Electrohydrodynamic, Enclosure, Heat transfer, Joule heating

Nomenclature

A	Area of heated plate, m^2		***Greek symbols***
a	Vertical position of emitting electrode, cm	α	Thermal diffusivity, 1.9×10^{-5} m^2/s
b	Distance between emitting wire and grounded plate, cm	β	Expansion coefficient, 1/k
B	Ion mobility, 1×10^{-4} $m^2/V.s$	δ_{ij}	Kronecker delta
C_p	Specific heat coefficient, 1006.43 J/kg.K	ε_0	Permittivity, 8.8542×10^{-12} F/m
D_e	Charge diffusion coefficient, m^2/s	ε	Turbulence dissipation rate, W
E	Electric field strength, V/m	η	Electrohydrodynamic performance
F_e	Electrohydrodynamic force, N/m^3	μ	Dynamic viscosity, 1.789×10^{-5} kg/m.s
g	Acceleration due to gravity, 9.81 m/s^2	υ	Kinematic viscosity, 1.45×10^{-5} kg/m.s
h	Convective heat transfer coefficient, W/m^2K	ρ	Density, 1.225 kg/m^3
H	Enclosure height, 0.4 m	ρ_c	Space charge density, C/m^3
I	Current, A	σ_k	Prandtl number for turbulent kinetic energy