Nonlinear rotating convection in Dielectric fluids under the presence of a vertical ac electric field

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ABSTRACT

The finite amplitude convection of a dielectric fluid confined between two horizontal planes heated from below under the combined action of a vertical AC electric field and uniform rotation with stress-free boundary conditions has been examined in this study by performing linear and nonlinear stability analysis. The nonlinear governing equations describing the motion, temperature, and electric fields are expanded as a sequence of non-homogeneous linear equations, which depend on the solutions of the linear stability problem. The perturbation method proposed by Kuo [1] is used to highlight the heat transfer features with the rotation of the electric field. An explicit expression at the onset of convection in terms of the parameters of the system is obtained. The dependence of heat transfer rate with rotation on Rayleigh number (R), electric Rayleigh number (L), Prandtl number (Pr), and Taylor number (Ta) is extensively examined until the eighth order using an expansion of R. To analyse the flow field and heat transfer characteristics with rotation for different control parameters that arise in the system, streamlines and isotherms are used in respect. The concept of heat function is used to depict the convective heat transport channel and thoroughly examined the energy distribution using heatlines. It is observed that rotation has a stabilising effect, whereas a vertical AC electric field has a destabilising effect on the convective system.

METHOD OF SOLUTION

Following Kuo [1] the solution in a power series in the parameter ($\epsilon < 1$) is expanded as

ϵ^2= (R-R_{0})/R. The solution of basic equations are written as f= $\epsilon f_1+\epsilon^2 f_2+ \epsilon^3 f_3+\epsilon^4 f_4+$…….

REFERENCES

[1]. S. Chandrasekhar, 1961, ``Hydrodynamic and Hydromagnetic Stability'', Oxford Clarendon Press.

[2]. Takashima, M. "The effect of rotation on electrohydrodynamic instability." *Canadian Journal of Physics* 54.3 (1976): 342-347.

[3]. H. L. Kuo, 1961, ``Solution of the non-linear equations of the cellular convection and heat transport'', J. Fluid Mech, 10, pp. 611-630