Classical Rayleigh–Bénard Convection: Influence of Copper nano-particles and boundary conditions

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1. INTRODUCTION & OBJECTIVE

The influence of nano-particles on the onset of Rayleigh-Bénard convection is a well studied topic([1], [2], [3], [4], [5] and references therein). Free-free isothermal boundaries are artificial boundary conditions while rigid-rigid isothermal are realistic(particularly realistic). Most of the works on this particular topic do not consider the radiation type of boundary condition which is the most practical one. Realistic boundaries demand the use of a non analytic procedure to obtain the eigenvalues of the problem that signifies the critical temperature difference of the two horizontal plates exceeds the threshold value thereby leading to the circulation of the fluid in the form of longitudinal rolls. The differential transform method shall be used to find the eigenvalues for different combinations of parameters.

2. RESULTS AND HIGHLIGHTS OF IMPORTANT POINTS

The influence of spherical copper nano-particles well dispersed in a Newtonian fluid (water) on the onset of the classical Rayleigh-Bénard convection is investigated using the assumptions of longitudinal roles. The boundary eigenvalue problem with Rayleigh number as the eigenvalue is solved by an innovative procedure that makes use of the differential transform method. The critical eigenvalue is obtained quite accurately within an error of 10^{-4} . The results are compared with those of pure isothermal boundaries.

REFERENCES

[1] P. G. Siddheshwar, C. Kanchana, Y. Kakimoto, and A. Nakayama, “Steady finite-amplitude Rayleigh–Bénard convection in nanoliquids using a two-phase model: theoretical answer to the phenomenon of enhanced heat transfer,”*J. Heat Transfer*, **139**, no.1, pp. 012402, 2013.

[2] P. G. Siddheshwar, and C. Kanchana, "Unicellular unsteady Rayleigh–Bénard convection in Newtonian liquids and Newtonian nanoliquids occupying enclosures: new findings,"*Int. J. Mech. Sci.* , **131**, pp. 1061–1072, 2017.

[3] Yi Zhao, and P. G. Siddheshwar, "A comparative study of individual influences of suspended multiwalled carbon nanotubes and alumina nanoparticles on Rayleigh-Bénard convection in water,"*Phys. Fluids*, **30**, no.8, pp. 084101, 2018.

[4] C. Kanchana, Yongqing Su, and Yi Zhao, "Regular and chaotic Rayleigh-Bénard convective motions in methanol and water,"*Commun. Nonlinear Sci. Numer. Simul*. , **83**, pp. 105129, 2020.

[5] C. Kanchana, P. G. Siddheshwar, and Zhao Yi, "The effect of boundary conditions on the onset of chaos in Rayleigh–Bénard convection using energy-conserving Lorenz models,"*Appl. Math. Model.* , **88**, pp. 349–366, 2020.