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Rayleigh-Bénard-Taylor Convection of Newtonian Nanoliquid

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Abstract : In the paper we make linear and non-linear stability analyses of Rayleigh-Bénard convection of a Newtonian nanoliquid in a rotating medium (called as Rayleigh-Bénard-Taylor convection). Rigid-rigid isothermal boundaries are considered for investigation. Khanafer-Vafai-Lightstone single phase model is used for studying instabilities in nanoliquids. Various thermophysical properties of nanoliquid are obtained using phenomenological laws and mixture theory. The eigen boundary value problem is solved for the Rayleigh number using an analytical method by considering trigonometric eigen functions. We observe that the critical nanoliquid Rayleigh number is less than that of the base liquid. Thus the onset of convection is advanced due to the addition of nanoparticles. So, increase in volume fraction leads to advanced onset and thereby increase in heat transport. The amplitudes of convective modes required for estimating the heat transport are determined analytically. The tri-modal standard Lorenz model is derived for the steady state assuming small scale convective motions. The effect of rotation on the onset of convection and on heat transport is investigated and depicted graphically. It is observed that the onset of convection is delayed due to rotation and hence leads to decrease in heat transport. Hence, rotation has a stabilizing effect on the system. This is due to the fact that the energy of the system is used to create the component V. We observe that the amount of heat transport is less in the case of rigid-rigid isothermal boundaries compared to free-free isothermal boundaries.

Keywords : nanoliquid, rigid-rigid, rotation, single phase
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