“PAPER FOR THE YOUNG SCIENTIST AWARD”

Effect of modulation on the onset of thermal convection in superposed fluid and porous layers

Tanya Rastogi

Department of Mathematics, Malaviya National Institute of Technology, Jaipur-302017, Rajasthan, India

The stability of Rayleigh-Bénard convection (RBC) in a superposed system consisting of a horizontal fluid layer overlying a fluid-saturated porous layer is investigated in the present article. A temperature distribution periodic in nature is applied at the bottom surface, and the heat transfer through the upper surface is represented by a thermal boundary condition depending on the Biot number. The Darcy law describes the fluid motion in the porous layer, and the Beavers-Joseph condition is employed at the interface of the two domains. Chebyshev tau method and Fourier series expansion are employed to reduce the governing partial differential equations to a generalized matrix eigenvalue problem, which is then solved to discuss the stability of the time-periodic system. Setting the depth ratio $\hat{d}$ to infinity yields the effect of the oscillatory temperature field on RBC in a fluid layer squeezed between two rigid walls; similarly, setting $\hat{d}$ to zero yields the result of applying modulated temperature in a porous domain confined between two impermeable walls. In a double-layer system, with $\hat{d} = 1$, it is noted that modulation can effectively regulate the commencement of convection in the superposed system for isothermal and adiabatic upper surfaces. Both ratios of thermal diffusivities and volumetric heat capacities are found to be able to enhance or reduce the effect of modulation. In the case of $\hat{d} < 1$, the convection dominated by the porous or the fluid domain can be controlled by applying the modulation.

Keywords: Superposed layers, temperature modulation, Rayleigh- Bénard convection, Chebyshev tau method, porous media.