Natural convection in a fluid saturating an anisotropic porous medium in LTNE: effect of depth-dependent viscosity. (English)  
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Summary: Thermal convection in a fluid saturating an anisotropic porous medium in local thermal nonequilibrium (LTNE) is investigated, with specific attention to the effect of variable viscosity on the onset of convection. Many fluids show a remarkable dependence of viscosity on temperature that cannot be neglected. For this reason, we take into account a fluid whose viscosity decreases exponentially with depth, according to Straughan (Acta Mech. 61:59-72, 1986), Torrance and Turcotte (J. Fluid Mech. 47(1):113-125, 1971). The novelty of this paper is to highlight how variable viscosity coupled with the LTNE assumption affects the onset of convection. A numerical procedure shows the destabilising effect of depth-dependent viscosity. Moreover, it comes out that the LTNE hypothesis makes the influence of viscosity more intense. Linear instability analysis of the conduction solution is carried out by means of the Chebyshev-tau method coupled to the QZ algorithm, which provides the critical Rayleigh number for the onset of convection in a straightforward way. The energy method is employed in order to study the nonlinear stability. The optimal result of coincidence between the linear instability threshold and the global nonlinear stability threshold is obtained. The influence of anisotropic permeability and conductivity, weighted conductivity ratio, and interaction coefficient on the onset of convection is highlighted.

MSC:
76Exx Hydrodynamic stability
76Sxx Flows in porous media; filtration; seepage
80Axx Thermodynamics and heat transfer

Full Text: DOI

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