RJPHY Research Journal of Physics

OPEN ACCESS

News & Comments

Free Convection of a Bingham Fluid in an Inversely Heated Porous Cavity

Victoria Mbachu

Understanding the movement of Bingham fluids through a porous material is of great interest. The existence of a yield stress, which causes the fluid to remain stagnant anytime an applied tension smaller than that yield stress acts on it, makes modelling such flows extremely difficult. In particular, the flow's strength and direction, which are both caused by pressure gradients of a certain magnitude, depend on the gradient's direction. When the pressure gradient is parallel to the channels and at a 45° angle to the channels, the flow rate is maximized. This is an Anisotropy caused by yield stress, whereas a network of this type is isotropic when the saturating fluid is Newtonian. The current work is the most recent in a series that examines how adding a Bingham fluid to a porous medium affects classical convective flows in that medium. Usually, the Rees-Bingham number, Rb, and the Darcy-Rayleigh number, Ra, will control such flows. The microstructure used in this paper is based on a standard set of horizontal and vertical channels. This means that, in addition to fluid movement in both directions, horizontal stagnation is now a possibility. The resulting flows were first supposed to always be stable, distinct for a given parameter set, and composed of a single circulating cell. A horizontal layer heated from below corresponds to the Darcy-Bénard issue. There is a crucial Darcy-Rayleigh number for a Newtonian fluid at which convection occurs. When a Bingham fluid fills the porous media, its stability characteristics are also qualitatively changed. Since disturbances must now be of finite magnitude to pass the yield threshold, there is no longer a linear stability threshold. The effects of a porous microstructure with horizontal and vertical channels on the convection patterns in a sidewall-heated porous cavity with saturated pores have been calculated by the authors. The numerical approach was briefly explained, and the macroscopic governing equations were deduced. Appendix A's detailed discussion of the key challenges posed by a parameter set near to the convection's commencement. In general, it was discovered that when convection occurs, the cavity is divided into nine regions: one with complete stagnation, two each with either vertical stagnation (i.e., purely horizontal motion) or horizontal stagnation (i.e., purely vertical motion), and four with complete non-stagnation of the fluid.

JOURNAL REFERENCE

Rees DAS. Free Convection of a Bingham Fluid in a Differentially-Heated Porous Cavity: The Effect of a Square Grid Microstructure. Physics. 2022; 4(1):202-216 .

KEYWORDS

Bingham fluid, porous media, free convection, anisotropic