Thesis Abstract

The study of double-diffusive convective instability in a fluid saturated porous medium is gaining considerable attention due to its growing applications in both natural and industrial processes such as enhanced oil recovery technology, food processing industry etc. The study of onset of double-diffusive convective instability in a power-law fluid-saturated porous medium is initiated in this thesis, considering the viscous dissipation, the Soret effect, and the concentration based internal heat source, along with the vertical/horizontal throughflow in the medium. These investigations help us to gain more insight into the tertiary oil recovery technology.

Using the generalized Darcy's law for the power-law fluid flow, conservation of thermal energy and species concentration equations, the governing equations for the Double-diffusive convection are reduced to eigenvalue problems under the framework of the linear stability analysis. These problems are solved using the two-term Gelarkin method or the relevant routines in MATLAB and `Mathematica` software. The complete list of parameters that influence the onset of instability of the basic state solution are the Péclet number Pe, the buoyancy ratio N, the Lewis number Le, the viscous dissipation parameter Ge, the Soret parameter Sr, Biot numbers B_0 and B_1, power law index n, concentration based internal heat source parameter γ. A physically realistic range of these parameters is considered. Diffusivity ratio Le plays a crucial role in the double-diffusive convective process, both the longitudinal and transverse rolls are investigated thoroughly for the onset of instability in horizontal throughflow in the porous medium for both aiding ($N > 0$) and opposing buoyancy ($N < 0$) cases. Limiting behavior of those parameters for which the basic temperature and concentration profiles are singular is also investigated for the onset of instability. The parameters that are responsible for the onset of oscillatory convective instability for the transverse rolls is identified and these instability boundaries are depicted. Crucial revelations with respect to Sr, Le, Ge, N and γ for the dilatant ($n > 1$) and the pseudoplastic ($n < 1$) fluids are tabulated/graphically presented.

Keywords : Porous medium; Power-law fluid; Double-diffusive convective instability; viscous dissipation; Soret effect; Concentration based internal heat source; Vertical throughflow; Horizontal throughflow; Asymptotic analysis.