Texas Tech University - Department of Mathematics and Statistics

Seminar in Applied Mathematics

A family of steady two-phase generalized Forchheimer flows and their linear stability analysis

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ABSTRACT. We model multi-dimensional two-phase flows of incompressible fluids in porous media using generalized Forchheimer equations and the capillary pressure. Firstly, we find a family of steady state solutions whose saturation and pressure are radially symmetric and velocities are rotation-invariant. Their properties are investigated based on relations between the capillary pressure, each phase's relative permeability and Forchheimer polynomial. Secondly, we analyze the linear stability of those steady states. The linearized system is derived and reduced to a parabolic equation for the saturation. This equation has a special structure depending on the steady states which we exploit to prove two new forms of the lemma of growth of Landis-type in both bounded and unbounded domains. Using these lemmas, qualitative properties of the solution of the linearized equation are studied in details. In bounded domains, we show that the solution decays exponentially in time. In unbounded domains, in addition to their stability, the solution decays to zero as the spatial variables tend to infinity. The Bernstein technique is also used in estimating the velocities.