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NONLINEAR INSTABILITY OF TWO SUPERPOSED MAGNETIC FLUIDS IN POROUS MEDIA UNDER VERTICAL MAGNETIC FIELDS

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ABSTRACT. The nonlinear analysis of the Rayleigh-Taylor instability of two immiscible, viscous magnetic fluids in porous media, is performed for two layers, each has a finite depth. The system is subjected to both vertical vibrations and normal magnetic fields. The influence of both surface tension and gravity force is taken into account. Although the motions are assumed to be irrotational in each fluid for small perturbations, weak viscous effects are included in the boundary condition of the normal stress balance. The method of multiple scale expansion is used for the investigation. The evolution of the amplitude is governed by a nonlinear Ginzburg-Landau equation which gives the criterion for modulational instability. When the viscosity and Darcy's coefficients are neglected, the cubic nonlinear Schrödinger equation is obtained. Further, it is shown that, near the marginal state, a nonlinear diffusion equation is obtained in the presence of both viscosity and Darcy's coefficients. Stability analysis and numerical simulations are used to describe linear and nonlinear stages of the interface evolution and then the stability diagrams are obtained. Regions of stability and instability are identified.

1 Introduction The stability problem is very important in many industrial applications, e.g., in the mechanical, chemical and nuclear engineering industries. It is well known that stability controls are generally required in precision for finishing processes of coating, laser cutting, and casting production. The further application to the stability analysis involves the coating of a moving solid substrate by a liquid layer, resort to dynamic wetting. Since macroscopic instability can cause detrimental conditions to film flows, and thus, can be very harmful to the quality

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