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NONLINEAR INSTABILITY OF FERROFLUIDS IN POROUS MEDIA UNDER A HORIZONTAL MAGNETIC FIELD

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ABSTRACT

The nonlinear instability analysis of the free surface of two weak viscous magnetic fluids, subjected to vertical vibrations and a horizontal magnetic field, has been examined in porous media. The two fluids are immiscible in all properties. Both have finite-thickness, homogeneous, and incompressible fluids. Although the motions are assumed to be irrotational, weak viscous effects are included in the boundary conditions of the normal stress tensor balance. The influence of both surface tension and gravity force is also considered. The method of multiple scale perturbations is used to obtain a dispersion relation for the linear theory and a Ginzburg-Landau equation for the nonlinear theory, describing the behaviour of the system. There is also the obtaining of a nonlinear diffusion equation, describing the evolution of the wave packets, near the marginal state. Further, the nonlinear Schrodinger equation is obtained when the effect of both the viscosity and Darcy's coefficients are neglected. The stability conditions are discussed and the interplay between the applied magnetic field and several other factors in determining the interface behaviour is analyzed. Stability analysis and numerical calculations are used to describe linear and nonlinear stages of the interface evolution. The numerical calculations indicate the existence of more than a new region of stability and instability due to the nonlinear effects. In the linear theory, it is found that the horizontal magnetic field decreases as the wave number increases. This means that the magnetic field has a stabilizing influence on the wave motion. While the viscosity and Darcy's coefficients have a destabilizing effect. In the nonlinear theory, it is found that these parameters have an important role in the stability criterion of the problem.

INTRODUCTION

Ferrofluids, also known as magnetic fluids, are composed of three fundamental components: magnetic particles, surfactant and base oil. The study of various phenomena of ferrofluids is of fundamental interest and importance with respect to the variety of applications.

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