Electroviscoelastic Rayleigh–Taylor instability of Kelvin fluids. Effect of a constant tangential electric field

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By using the method of multiple scales, an investigation of the Rayleigh–Taylor problem of interfacial stability in a two-layer system of electroviscoelastic Kelvin fluids is performed. Examination of the effects on the stability of the interface by applying a constant tangential electric field is made. Through the linear perturbation analysis a fourth-order partial differential equation which governs the motion of rheological fluids is obtained. The scheme reported here depends on the idea that the flow of a slightly non-Newtonian fluid is about the same as that for a Newtonian fluid. The contribution of elasticity is included in the first-order problem. A solvability condition is obtained in this analysis. A first-order differential equation which controls the surface deflection is obtained and solved. Also, stability conditions are introduced theoretically. Some graphs are drawn to indicate the stability regions. The case of large viscosity is considered for numerical calculations. It is found that the elasticity parameter plays a destabilizing role under the effect of a tangential electric field, while the viscosity having a damping nature in Newtonian fluids plays a dual role in non-Newtonian fluids. It is shown that the electric field plays a dual role in stability criteria.