Long-Wave Instabilities of Viscoelastic Fluid Film Flowing Down an Inclined Plane with Linear Temperature Variation

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The two dimensional flow of a viscoelastic fluid (weakly elastic) represented by Walters' B″ model running down an inclined heated plane with linear temperature variation has been investigated in the finite amplitude regime. A long-wave expansion method obtains a nonlinear evolution equation of the film interface. A normal mode approach and the method of multiple scales are used to obtain the linear and nonlinear stability solutions for the film flow. The study reveals that both supercritical stability and subcritical instability are possible for this type of film flow. The influence of the viscoelastic parameter and the Marangoni number on the different zones, the amplitude of the disturbances on sub/supercritical region, and the nonlinear phase speed in the supercritical region are also investigated. It is interesting to note that the influence of the viscoelastic parameter on the above aspects are very significant at low Marangoni number, while it has very feeble impact at high Marangoni number. Finally, the results thus determined are interpreted physically.

Key words: Thin Film; Viscoelastic Fluid; Finite Amplitude Stability Analysis; Marangoni Instability.
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