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A comparative study of two different numerical schemes for the simulation of nonlinear dynamics of heated falling thin films (Article)

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Abstract

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In this research, an attempt is made to characterise qualitatively the stability and dynamics of an inclined thin liquid film under the influence of instabilities due to thermo-capillarity and evaporative effects as well as van der Waals intermolecular forces, by employing the implicit finite difference method. The results are compared with solutions obtained by the Fourier spectral method. Flow in thin films of a Newtonian liquid on an inclined plane with an adjacent passive gas layer, is well represented by the Navier-Stokes equations, equation of continuity and associated boundary conditions. Long-wave (lubrication) approximation is applied to simplify the governing equations to arrive at a nonlinear partial differential equation, called equation of evolution (EOE). The spatio-temporal evolution of the interfacial instability in the film caused by internal and/or external effects are studied by numerically solving the EOE using the implicit finite difference method. The results of the numerical simulations of our thin film model are compared with those of a similar problem solved using Fourier spectral method from the literature. Simulations show remarkable agreement in the film dynamics predicted by these two methods. The film rupture times obtained using our implicit finite difference scheme closely match with the values obtained from the Fourier spectral method within less than 1% error. This implies that the implicit finite difference method can be satisfactorily employed for the efficient numerical simulation of the thin film flows, and to decipher its nonlinear dynamics reliably. © BEIESP.

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