

Document details

[< Back to results](#) | 1 of 1[Export](#) [Download](#) [Print](#) [E-mail](#) [Save to PDF](#) [Add to List](#) [More...](#)International Journal of Recent Technology and Engineering
Volume 7, Issue 6, March 2019, Pages 100-105

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

Hamza, M.A.^a, Jameel, A.T.^b, Asrar, W.^a^aMechanical Engineering Department, Kulliyyah (Faculty) of Engineering, International Islamic University Malaysia, P.O. Box 10, Gombak, Kuala Lumpur, 50728, Malaysia^bBiotechnology Engineering Department, Kulliyyah (Faculty) of Engineering, International Islamic University Malaysia, P.O. Box 10, Gombak, Kuala Lumpur, 50728, Malaysia

Abstract

[View references \(14\)](#)

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.

SciVal Topic Prominence

Topic: Liquid films | Films | Film flows

Prominence percentile: 89.811

Author keywords

[Implicit finite difference](#) [Long-wave instability](#) [Nonlinear dynamics](#) [Spectral method](#) [Thin liquid film](#)

Funding details

Funding sponsor	Funding number	Acronym
Ministry of Higher Education, Malaysia	FRGS 03-08-89	

Funding text

The financial assistance from the Ministry of Higher Education of Malaysia vide grant FRGS 03-08-89 is gratefully acknowledged. The authors wish to express their gratitude to Dr. Asif Hoda (Jubail University College, Saudi Arabia) for his generous help in implementing the Fortran code on the MATLAB platform.

Metrics

0 Citations in Scopus

0 Field-Weighted Citation Impact



PlumX Metrics

Usage, Captures, Mentions, Social Media and Citations beyond Scopus.

Cited by 0 documents

Inform me when this document is cited in Scopus:

[Set citation alert >](#)[Set citation feed >](#)

Related documents

Numerical simulation of non-isothermal thin liquid film flow on inclined plane using an implicit finite difference scheme

Hamza, M.A. , Jameel, A.T. , Asrar, W. (2017) *IOP Conference Series: Materials Science and Engineering*

Numerical simulation of non-isothermal thin liquid film flow on inclined plane using an implicit finite difference scheme




Hamza, M.A. , Jameel, A.T. , Asrar, W. (2017) *IOP Conference Series: Materials Science and Engineering*

Stability and rupture of nano-liquid film (NLF) flowing down an inclined plane

Ali, M.A. , Jameel, A.T. , Ahmadun, F.-R. (2005) *Computers and Chemical Engineering*

References (14)

[View in search results format >](#)

All [Export](#)  [Print](#)  [E-mail](#)  [Save to PDF](#) [Create bibliography](#)

1 Bikerman, J.J.
(1973) *Foams*. Cited 612 times.
Springer, New York

2 Gaines, G.L.
(1996) *Insoluble Monolayers at Liquid-Gas Interfaces*. Cited 3756 times.
Interscience, New York

3 Sharma, A., Jameel, A.T.
Nonlinear stability, rupture, and morphological phase separation of thin fluid films on apolar and polar substrates

(1993) *Journal of Colloid And Interface Science*, 161 (1), pp. 190-208. Cited 151 times.
doi: 10.1006/jcis.1993.1458

[View at Publisher](#)

4 Sharma, A., Ruckenstein, E.
An analytical nonlinear theory of thin film rupture and its application to wetting films

(1986) *Journal of Colloid And Interface Science*, 113 (2), pp. 456-479. Cited 120 times.
doi: 10.1016/0021-9797(86)90181-5

[View at Publisher](#)

5 Grotberg, J.B.
Pulmonary flow and transport phenomena

(1994) *Annual Review of Fluid Mechanics*, 26 (1), pp. 529-571. Cited 188 times.

[View at Publisher](#)

6 Wong, H., Fatt, I., Radke, C.J.
Deposition and thinning of the human tear film

(1996) *Journal of Colloid and Interface Science*, 184 (1), pp. 44-51. Cited 148 times.
<http://www.elsevier.com/inca/publications/store/6/2/2/8/6/1/index.htm>
doi: 10.1006/jcis.1996.0595

[View at Publisher](#)

7 Benny, D.J.
Long waves on liquid films
(1966) *J. Mathematics and Physics*, 45, pp. 150-155. Cited 613 times.