UNIVERSITI TEKNOLOGI MARA

UNSTEADY THIN RIVULET FLOW OF NEWTONIAN AND POWER-LAW FLUIDS WITH STRONG SURFACE-TENSION EFFECT

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ABSTRACT

Thin rivulet flow on an inclined plane is important in many industrial and natural processes. This study investigates the unsteady thin rivulet flow of Newtonian and power-law fluids on an inclined plane, focusing on the effects of strong surface-tension on the flow height and width over time. The governing equations are derived from the Navier-Stokes equations using the lubrication approximation and appropriate boundary conditions, including the kinematic condition and the balances of normal and shear stress. Similarity transformations are applied to reduce the governing equations to an ordinary differential equation. The resulting equation is solved numerically using the Cash-Karp method and the results are validated with the Runge-Kutta-Fehlberg fourth-fifth order (RKF45) method. The results using the Cash-Karp method show that physically realisable solutions are obtained. Specifically, solutions occur for $H_2 \leq 0$ and an increase in the power-law index leads to wider rivulets. These results show that the rivulet widens and thickens over time while narrowing and thinning at a given position. These results help to better understand the behaviour of thin rivulet flow and can be applied in areas such as coating processes, microfluidics and other engineering applications involving Newtonian and non-Newtonian fluids.