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Simulation of a falling droplet in a vertical channel with rectangular obstacles

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Abstract

Droplet microfluidic systems have attracted a large amount of research due to their numerous applications in biomedical micro-devices and drug discovery/delivery platforms. One of the most important problems in such systems is to investigate deformation, coalescence, and breakup of droplets within the channel. The present study demonstrates numerical simulation of a falling droplet subject to gravitational force in a channel with embedded rectangular obstacles. The lattice Boltzmann method incorporated using He-Chen-Zhang method for two phase flow is employed. Two rectangular obstacles with inverse aspect ratios are introduced to investigate the mechanism of breakup and deformation of the droplet. The influence of gravity magnitude, viscosity and surface tension on the deformation rate of droplet for two different aspect ratios of the obstacle is studied. It is observed that increasing the gravity force, decreasing the viscosity or surface tension increase droplet deformation rate resulting in more stretched filaments and so breakup occurs in a shorter time.

Keywords: Two phase flow; Lattice Boltzmann method; Falling droplet; Rectangular obstacle; Vertical channel.