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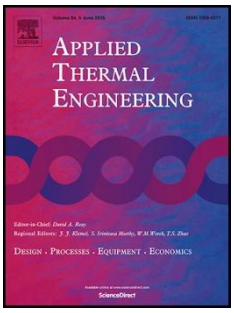

Title: Simulation of double droplets impact on liquid film by a simplified lattice Boltzmann Model

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Simulation of double droplets impact on liquid film by a simplified lattice Boltzmann Model

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Highlights

- A stable two-phase lattice Boltzmann model with large density ratio was presented.
- A simplified model was proposed to significantly reduce the calculated quantity.
- Double droplets impingement process was simulated by the proposed simplified model.
- Various influence factors of the impingement process were considered and discussed.

Abstract: A simplified method is proposed to reduce the calculated quantity of two-phase lattice Boltzmann (LB) model for large density ratio. The simplified model not only apparently reduces the calculated quantity but also has a good stability for two-phase flow with large density ratio. Based on the simplified two-phase LB model, the impingement of droplet onto a stationary liquid film is simulated. The simulation of single droplet impacts onto liquid film is used to verify the applicability of the simplified model for the impingement process. It shows that the results calculated by the simplified model are in good agreement with experimental data in published paper. Then, the impingement process of double droplets with a horizontal distance and time interval onto a liquid film is simulated by two-phase lattice Boltzmann model. Different horizontal distances, droplet diameters, impact velocities, Reynolds numbers, relative film thicknesses and time intervals between the droplets are considered. The mechanism of the impingement process is analyzed. The rule of middle splash height is obtained. The changing rule of the middle splash height and the horizontal distance has a relationship with the droplet diameter. Larger Reynolds number makes height rise faster. Thicker liquid film leads a higher height but a slower rising rate. The time interval between the droplets would destroy the symmetry and make the flow become complex. It changes the middle splash direction and lowers the splash height. The flow mechanism of the impingement process is elaborated.

Key words: two-phase flow; lattice Boltzmann method; droplet impingement; splashing.

1 Introduction

Atomization spray is a common fluid phenomenon in industrial devices, such as ink-jet printing, the corrosion of turbines blades, the nozzle spray in diesel, and so on. And it's also an important foundation of heat and mass transfer, hence, it's necessary to study the process of atomization spray. In the process of atomization spray, the atomized droplets crashed on the solid surface or liquid film on it which is regarded as impingement process. The impingement process of droplet onto liquid film is such a complex dynamic process which determines the performance of the equipment, accompanied by droplet deformation, coalescence, spreading, bouncing, splashing, breakup, and so on [1, 2]. And the splashing occurred during impingement process is the major phenomenon which is crucial in guaranteeing safety operation of the equipment, especially in packed tower-type chemical equipment, such as, cooling tower and falling film evaporators. Therefore, it's essential to understand the underlying mechanisms of the flow phenomenon as

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