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NUMERICAL SIMULATION OF WATER DROPLET IMPACT ON HEATED SURFACE UNDER MICROGRAVITY: EFFECT OF EVAPORATION

Abstract

The impact process of a water droplet upon heated surface in spray cooling under microgravity was numerically simulated. Initial substrate temperature was set to 120oC, and impact velocities of water droplet were from 1 to 4m/s with droplet diameter of 2.0mm. The transient calculations were based on the Finite Volume Method (FVM) of Navier-Stokes (NS) Equation using a “Volume of Fluid” (VOF) mode.

Considering the droplet dimension and the impact time both were extremely small, we could hypothesize the evaporation was a relatively slow process relative to convection and conduction when the droplet touched the hot surface. It was a novel and fascinating problem. Firstly, computations of water droplet shape under same conditions agreed well with predecessor’s experimental results. In order to investigate the effect of evaporation, the solutions were analyzed from adding evaporative phase source terms to governing equations compared to without these terms. The effects of wettability, viscosity, surface tension, and impact velocity on the droplet spreading and recoiling behavior and wall heat flux were assessed. It was found that, there were no obvious differences whether or not to have evaporation terms. However, the wall heat flux distribution was clearly affected by the evaporation. Overall, we concluded that the most important parameters affecting heat transfer were the fluid properties and impact velocity, but the evaporation effect was not critical factor when the substrate temperature was not higher than boiling point of water enough.

Key words: Droplet impact, Evaporation, Numerical simulation, Spray cooling