NUMERICAL STUDIES OF TEMPERATURE REGIMES OF THIN FILMS OF THERMOCAPILLARY SYSTEMS

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The purpose of the work is to determine the effect of the heating temperature on the formation of a thin film in the thermocapillary system by numerical simulation.

Results.

The thermophysical system in which the liquid flows from the microcapillary onto a flat heated surface is considered. On a flat surface a thin evaporating film is formed. It was necessary to determine the temperature of the heating, in which the film evaporates without perturbations and discontinuities.

The simulation has been carried out in a two-dimensional setting. The computational domain was a rectangular shape with dimensions of $1\cdot10^{-5} \times 5\cdot10^{-4}$ m. A two-phase VOF-model designed to solve the problems with the phase interface was applied for simulations. Water was chosen as the main phase and the second phase was water vapor. The gravity and the surface tension forces were taken into account.

The initial water configuration is chosen so that the surface shape is formed naturally. The simulation was carried out in two stages - the formation of a film with low heating and then the actual choice of the heating temperature of the already formed film.

To perform a grid-independence study, three sizes of the grids have been validated in the simulations: a coarse grid with the discretization size of 1.0×10^{-6}, a fine grid with the discretization size of 2.5×10^{-7} m, and a very fine grid with the discretization size of 1.0×10^{-7}. The grid sized were 4400 cells, 70,400 cells and 440,000 cells, respectively. The velocity and temperature distributions for the fine and very fine grids differed from each other by not more than 0.5%. Therefore, the fine grid has been chosen for all subsequent simulations.

Conclusion

Simulations demonstrated that at small values of the temperature difference across the film (less than 1 °), the liquid film developed steadily with no visible disturbances. For large values (more than 2,4 °), noticeable disturbances arose in the film. These disturbances escalated with time and lead to the disruption of the film.