Accepted Manuscript

Kinetic boundary condition in vapor–liquid two-phase system during unsteady net evaporation/condensation

Misaki Kon, Kazumichi Kobayashi, Masao Watanabe

PII: S0997-7546(16)30111-X
DOI: http://dx.doi.org/10.1016/j.euromechflu.2016.12.001
Reference: EJMFLU 3104

To appear in: *European Journal of Mechanics B/Fluids*

Please cite this article as: M. Kon, K. Kobayashi, M. Watanabe, Kinetic boundary condition in vapor–liquid two-phase system during unsteady net evaporation/condensation, *European Journal of Mechanics B/Fluids* (2016), http://dx.doi.org/10.1016/j.euromechflu.2016.12.001

Kinetic boundary condition in vapor–liquid two-phase system during unsteady net evaporation/condensation

Misaki Kon[1,*], Kazumichi Kobayashi[1], Masao Watanabe[1]

Division of Mechanical and Space Engineering, Faculty of Engineering, Hokkaido University, Kita 13 Nishi 8, Kita-ku, Sapporo, Hokkaido 060-8628, Japan

Abstract

Heat and mass transfer caused by nonequilibrium phase change (net evaporation/condensation) plays an important role in a vapor–liquid two-phase flow. In general, liquid temperature changes with time because of the heat and mass transfer between the vapor and liquid phases; however, a precise investigation of the transport phenomena related to this temporal evolution of liquid temperature is still lacking. The aim of this study is to examine a kinetic boundary condition, which depends on liquid temperature, for the Boltzmann equation in a vapor–liquid two-phase system with unsteady net evaporation/condensation. In this study, we confirmed whether the kinetic boundary condition follows the temporal evolution of liquid temperature attributed to unsteady net evaporation/condensation by using the molecular simulation based on mean-field kinetic theory, and then we validated the accuracy of the kinetic boundary condition by solving the initial boundary value problem of the Boltzmann equation in unsteady net evaporation/condensation. These results showed that the kinetic boundary condition follows the temporal evolution of liquid temperature in the simulation setting of this study. Furthermore, we concluded that the kinetic boundary condition that depends on liquid temperature is guaranteed to be accurate even in unsteady net evaporation/condensation by considering the temporal evolution of liquid temperature.

Keywords: kinetic boundary condition, evaporation and condensation, unsteady vapor–liquid two-phase flow, kinetic theory of gases

1. Introduction

As micro/nanofluidics progresses, we should consider not only the *rarefaction effect* induced by the downsizing of a system but also nonequilibrium phase change (net evaporation/condensation) induced by molecular motion in the vicinity of the vapor–liquid

* *Email addresses:* konmi@eng.hokudai.ac.jp (Misaki Kon), kobakazu@eng.hokudai.ac.jp (Kazumichi Kobayashi), masao.watanabe@eng.hokudai.ac.jp (Masao Watanabe)