DOI: 10.32604/icces.2025.010544

PROCEEDINGS

Discrete Boltzmann Modeling and Simulation of Multiphase with Thermodynamic Nonequilibrium Effects

Chuandong Lin*

Sino-French Institute of Nuclear Engineering and Technology, Sun Yat-sen University, Zhuhai, 519082, China
*Corresponding Author: Chuandong Lin. Email: linchd3@mail.sysu.edu.cn

ABSTRACT

Multiphase flows with thermodynamic nonequilibrium effects are encountered in various engineering and natural systems, such as bubbly flows, droplet-laden flows, and phase change processes. To accurately model and simulate such complex flows, a Discrete Boltzmann Method (DBM) is introduced in this report. The DBM is a kinetic-based approach that can capture the dynamics of multiple phases and their interactions, including phase change, mass transfer, and energy exchange. The method is validated through simulations of multiphase flows with phase change, showing good agreement with analytical solutions. The capability of the DBM to handle thermodynamic nonequilibrium effects makes it a valuable tool for studying multiphase flows in various engineering and scientific fields. Unlike traditional continuum-based methods, the DBM can capture the thermodynamic nonequilibrium behaviors, allowing for a more detailed and accurate description of the flow physics. By accurately modeling these phenomena, the DBM can provide insights into heat and mass transfer processes, bubble dynamics, and droplet behavior in multiphase systems. From an academic perspective, the DBM expands the capabilities of existing modeling approaches and provides researchers with a powerful tool to investigate complex multiphase flow phenomena. In realistic applications, the DBM can be used to optimize the design and operation of multiphase flow systems, such as reactors, heat exchangers, and separation processes.

KEYWORDS

Discrete boltzmann method; multiphase; nonequilibrium effect; numerical simulation

Funding Statement: This work is supported by Guangdong Basic and Applied Basic Research Foundation (under Grant No. 2024A1515010927), Humanities and Social Science Foundation of the Ministry of Education in China (under Grant No. 24YJCZH163), and Fundamental Research Funds for the Central Universities, Sun Yat-sen University (under Grant No. 24qnpy044).

Conflicts of Interest: The author(s) declare(s) no conflicts of interest to report regarding the present study.