

ABSTRACT

ABSTRACT

In this thesis, a method of lattice Boltzmann is introduced. Unlike conventional CFD methods, the lattice Boltzmann method is based on microscopic models and mesoscopic kinetic equations in which the collective behavior of the particles in a system is used to simulate the continuum mechanics of the system. Due to this kinetic nature, the LBE method has been found to be particularly useful in applications involving interfacial dynamics and complex boundaries.

First, the methodology and general concepts of the lattice Boltzmann method are introduced. Following this introduction, a few simple isothermal flow simulations were done to show the effectiveness of this method.

Next, a thermal lattice Boltzmann model is developed to simulate incompressible thermal flow. The basic idea is to solve the velocity field and the temperature field using two different distribution functions. It is found that a new lattice type of four-velocity model (2-D) and eight-velocity model (3-D) for the internal energy density distribution function can be developed where the viscous and compressive heating effects are negligible. The discretised equilibrium distribution function for both density, f_i^{eq} and internal energy density distribution function, g_i^{eq} can also be obtained by applying the Gauss-Hermite quadrature procedure for the calculation of f^{eq} and g^{eq} velocity moments. In other words, the isothermal and thermal lattice Boltzmann equation have been directly derived from the Boltzmann equation by discretization in both time and phase space. Numerical result of the simulations of porous plate Couette flow and natural convection flow are presented in order to validate these new thermal models.

ABSTRACT

Lastly, the accomplishments of this study are summarized and future perspectives are provided.