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多相流和计算流体力学

基于格子Boltzmann方法的单颗粒绕流数值模拟

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摘要

采用格子Boltzmann方法（LBM）研究了单颗粒绕流流动过程。通过使用LBM中的LBGK（lattice Bhatnagar-Gross-Krook）模型和二阶精度的曲线边界条件处理方法，实现了对单颗粒绕流问题的定常及非定常流动过程中涡结构的模拟。采用动量交换法分别计算了Reynolds数在0.1～200范围内27个不同Reynolds数时的曳力系数，并将计算结果拟合得到基于LBM数值模拟的曳力曲线。计算结果表明，LBM在气固两相流的模拟计算中具有精确、可靠的优点，使用LBM模拟计算曳力曲线的方法经济、易行，并且可以克服由传统实验方法获得曳力曲线的局限性。

关键词

格子Boltzmann 方法 动量交换法 曳力系数 颗粒 两相流

分类号

Simulation of flow around a single particle based on lattice Boltzmann method

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Abstract

The lattice Boltzmann method（LBM）is an alternative kinetic-based approach in solving various hydrodynamics systems.The LBGK（lattice Bhatnagar-Gross-Krook）model of lattice Boltzmann method，including second-order boundary condition treatment for curve geometry was used to investigate the flow around a single particle.The evolution of vortex structure was analyzed to obtain the reasonable results at both steady and unsteady flows around the single particle.The drag coefficient is a key parameter in the analysis of particle-fluid complex systems，especially，in gas-solids fluidized bed.The drag coefficient was evaluated by using the momentum-exchange method over the range from Reynolds numbers 0.1 to 200，and the results agreed well with the standard equations or the published references.Moreover，this paper gives a new drag relationship based on LBM by using the least squares curve fitting method.Computational results indicate that LBM is an accurate and robust method for drag coefficient simulation.The simulated drag coefficient is more convenient and economical than that obtained by experiment.

Key words

lattice Boltzmann method momentum-exchange method drag coefficient particle two-phase flow

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