عنوان مقاله:

Numerical Study on Drag Reduction of Superhydrophobic Surfaces with Conical Microstructures in Laminar Flow

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خلاصه مقاله:

Superhydrophobic surfaces have garnered attention for their ability to decrease fluid resistance, which can significantly reduce energy consumption. This study aims to accurately capture critical flow phenomena in a microchannel and explore the internal drag-reduction mechanism of the flow field. To achieve this, the three-dimensional (۳D) superhydrophobic surface flow field with conical microstructure is numerically simulated using the gas-liquid two-phase flow theory and Volume of Fluid (VOF) model, combined with a Semi-implicit method for the pressure-linked equation (SIMPLE) algorithm. The surface drag-reduction effect of the conical microstructure is investigated and compared it to that of the V-longitudinal groove and V-transverse groove surfaces. Additionally, the changes in the drag-reduction effect during the wear of the conical microstructure were explored. The numerical results reveal that the drag-reduction effect improves with a larger period spacing of the conical microstructure, the drag reduction rate can reach ۲۵.۲۳%. As the height of the conical microstructure increases, the aspect ratio (ratio of width to height) decreases, and the dimensionless pressure drop ratio and the drag-reduction ratio increase. When the aspect ratio approaches ۱, the drag reduction rate can reach over ۲۸%. indicating a more effective drag-reduction. The microstructure is most effective in reducing drag at the beginning of the wear period but becomes less effective as the wear level increases, when the high wear reaches ۱۰, the drag reduction rate decreases to ۳%. Compared to the V-shaped longitudinal groove and V-shaped transverse grooves, the conical microstructure is the most effective in reducing drag.

کلمات کلیدی:

Superhydrophobic surface, Drag reduction, Numerical simulation, Conical microstructure, ۳D flow field