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Modeling of axial motion of small droplets deposited on smooth and rough fiber surfaces

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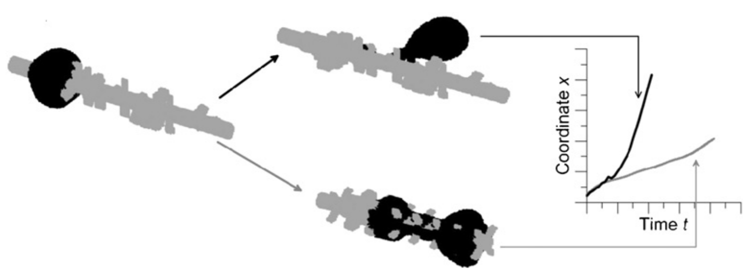
HIGHLIGHTS

- ► Two-color lattice Boltzmann model for simulations of a motion of droplet on fiber.
- ► Dependence of velocity and contact angle on gas velocity agree with theory.
- ► Velocity on rough fiber usually lower than on smooth one-triple line pining effect.
- ► Pining effect may cause the change of conformation of a droplet and its velocity.

GRAPHICAL ABSTRACT



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ABSTRACT

A two-color lattice-Boltzmann method (LBM) was used for simulation of the behavior of droplets deposited on a fiber. The interaction of the droplet with the gas flowing around a fiber having smooth and rough surfaces was analyzed. The equilibrium of conformation of droplets and their velocities were derived. The results of the calculation show the distinguished patterns of the interaction depending on the structure of the fiber roughness and the fiber and droplet dimensions.

1. Introduction

The separation of the liquid droplets from the stable mist system is a crucial process in industrial technologies, natural gas cleaning, crank case ventilation systems and many other applications. The most efficient devices for such separations are fibrous filters (coalescers). A properly designed coalescer structure, defined through the space distribution of the local porosity and fiber diameter involves the phenomena of a droplet coalescing in the bulk, deposition of drops on the fiber, coalescing of the deposited droplet on the fibers and the drainage of the loaded filter fibers.

There are few works concerning the motion and the shape of droplets collected on a fiber. In addition, most of the research is focused on the droplet behavior during interaction with a smooth fiber. In the work of Adam [1], we can find one of the first analyses of the shape of the droplet deposited on a smooth fiber. Generally, there are two possible, potentially stable conformations of the droplet on a fiber. One of them is an axis-symmetrical, also called a barrel shaped droplet, while another one, asymmetrical is known as a clamshell or pearl shaped droplet. At some conditions, such as proper diameter of the fiber, volume of the droplet and the contact angle, the transition between these two conformations

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