Coupled Temperature and Transport Effects on Biofilm Growth Using the Thermal Lattice Boltzmann Method

Mojtaba Aghajani Delavar[1] and Junye Wang[1]

[1]Athabasca University

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Abstract

In this study, we developed an integrated cellular automata and thermal lattice Boltzmann model to investigate the effects of different temperatures and velocities in a microbioreactor. Compared with previous studies this model accounted for the direct effects of transient temperature on biofilm growth and indirect effects caused by changes of properties. In addition, the algorithms on variations in solid boundary conditions, detachment and extra mass transport have been improved. Results showed that temperature affected both the maximum biofilm concentration and growth speed. Roughly a 10-75% increase in biofilm concentration was observed, while in some cases the time needed to reach maximum concentration decreased from 30 days to 5 days. Despite of geometrical symmetry, changes in the upper inlet characteristics were more effective on biofilm growth. This demonstrates the capability of the present model to simulate biofilm behaviour in the microbioreactor and its potential industrial and clinical applications.

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