SIMULATING BIOFILM GROWTH IN INDUSTRIAL APPLICATIONS

Thomas Pintelon[1], Sarah Creber[1], Daniel Graf von der Schulenburg[1], Michael Johns[1,*]
[1]*Department of Chemical Engineering and Biotechnology, University of Cambridge, Cambridge, UK*

To simulate the entire complexity of biofilm growth and its spatial heterogeneity on complex support structures, three-dimensional models are necessary. The Lattice-Boltzmann (LB) method was used to solve the coupled hydrodynamics and mass transport equations because of its proven high performance in simulating these processes in such arbitrary complex geometries. The fluid velocity, pressure and solute (nutrient) concentration fields calculated with LB were coupled with an individual based biofilm growth model (IbM) to simulate biofouling [1]. This method has been extended with a shear-induced biomass detachment technique based on a fast marching level set (FMLS) [2]. To deal with realistic biofilm growth scenarios, multiple relaxation time (MRT) LB was implemented enabling larger, more physically realistic, Reynolds numbers [3]. MRT LB also proved to be essential for the inclusion of variable biofilm permeability. This was implemented by allowing a spatial variation in *pseudo-viscosity* via spatial manipulation of the LB relaxation parameters (as was used in [4] to simulate non-Newtonian flow). Inoculation of bacterial cells was simulated using a LB platform complemented with a Lagrangian particle-tracking algorithm.

Two applications will be discussed in detail: (i) optimum (in terms of energy consumption) creation of biobarriers to control sub-surface pollution plumes in ground water; and (ii) biofouling of reverse osmosis membranes (ROM) which is problematic in water desalination processes. In the case of the ROMs, the simulation data will be validated against magnetic resonance imaging experimental results.

References:

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[*]Corresponding author, E-mail: mlj21@cam.ac.uk