הטכניון - מכון טכנולוגי לישראל

TECHNION - ISRAEL INSTITUTE OF TECHNOLOGY

הפקולטה להנדסה כימית
ע״ש וולפסון
The Wolfson Department of Chemical Engineering

Wolfson Department of Chemical Engineering Special Seminar
Meeting room 3rd floor, Wolfson Department of Chemical Engineering,
Thursday November 8th at 1:30pm

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Chemical Engineering, Technion

Modeling Hydrodynamic and Physicochemical Effects in Micro-Particle and Bacterium Deposition on Surfaces

Aquatic surfaces tend to get fouled over time by both non-living (particles, colloids, salts, organics and macromolecules) as well as living matter such as microorganisms. Fouling phenomena is associated with irreversible particle attachment that harms structures immersed or in contact with water, such as pipes, membranes, vascular grafts etc. and reduces their performance. This motivates search for anti-fouling surfaces, which requires a physical understanding and interpretation for bacterium and particle deposition on surfaces and their relation to surface characteristics. However, this effort and analysis of deposition data are impeded by lack of models that accurate predict the rate of deposition and its relation to the surface characteristics.

Parallel Plate Flow Chamber (PPFC), is a common setup for studying deposition of bacteria and particles. PPFC results are commonly analyzed using the classical Smoluchowski-Levich (SL) convection-diffusion model, which neglects gravity and lift forces and assumes a perfectly adsorbing surface. However, recent experiments on bacterial deposition and our data demonstrate that the SL solution doesn’t describe well even the observed trends. For instance, experiments show that deposition flux increases along the channel, while the SL model predicts a decreasing trend. The main goal of this work was to understand the reason for such discrepancy and propose a more adequate model that will cover a variety of particle-surface systems including deposition of bacterium cells.

We addressed the problem by incorporating into the convection-diffusion model additional effects, such as gravity, lift and adhesion. To address the complexity of adhesion force and near-surface hydrodynamics, we defined a kinetic parameter that enters through boundary conditions and serves as a simple and practical indicator of the propensity of the surface to fouling by particles or cells. The numerical solution of the model highlighted the fact that sedimentation (gravity) and adhesion forces are mainly responsible for the observed trends, which explains the poor agreement with the SL model. In addition, we develop approximate analytical relations that would allow a more facile parameter fitting and comparison with experimental results than full numerical solution. The new model may become a useful tool in analyzing deposition experiment and quantifying propensity of different surfaces to particle fouling and biofouling.

Refreshments will be served at 1:15 pm