528f Removal of Adhered Bacteria by Surfactant and Shear

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Adhesion of planctonic bacteria is the first step in biofilm formation. A common-sense approach to prevent biofilm formation is to use surfactants on sensitive surfaces to remove adherent cells before they can establish a biofilm. This work seeks to establish whether the timing of surfactant application is important to bacterial removal, and what rate of shear is required to effect the removal.

Stationary phase, non-motile E. coli bacteria were allowed to adhere to the surface of a clean glass capillary tube which had been pre-rinsed with either buffer or a nonionic surfactant solution (0.12mM Brij 30). Adhered cells were then exposed to a rinse of either buffer or a nonionic surfactant solution at mean fluid velocities between 0.104 cm/s and 62.5 cm/s . It was found that the maximum shear rate possible with the equipment (1.24x105N/m2) was not sufficient to remove cells in the absence of surfactant. In the presence of surfactant, cells were removed at even the lowest flow rate (2.29x102N/m2). A shear rate of 4.57x104N/m2 was required to remove 100% of cells in the presence of surfactant. A FEMLAB model of the system was constructed in order to characterize the flow field around the bacteria. The timing of surfactant addition (prior to, along with, or after bacterial adhesion) appeared to be unimportant, with fractional cellular removal reaching the same levels in all cases.

These results were described by a theoretical model relating the removal force on a cell to both the presence of surfactant and the drag force. Each of these terms was a function of fluid flow rate. Equilibrium surfactant sorption could only be reached in the longest rinse time cases (that is, at the lowest rinse flow rates), hence the apparent action of the surfactant was a function of the rinse fluid flow rate. The theoretical model as proposed describes the results and can be extended in the future as a simple tool to measure forces between cells and surfaces.