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GRAVITY AND MICROHYDRODYNAMIC EFFECTS ON BACTERIA TRANSPORT IN BIOCOLLOIDS

Abstract

We present a modeling and simulation approach for dilute suspensions of bacteria (biocolloids) in channels. We investigate the effects of shear, mean flow, bacteria concentration and gravity on the migration of bacteria towards channel surfaces. Migration of bacteria on surfaces can lead to the formation of a biofilm. The simulations are performed in conjunction with experiments using a flowing bioreactor referred to as Microhydrodynamics of Biocolloids in Channels (MOBIC). MOBIC consists of four 3mm x 3mm x 12 mm channels and allows flow rates to be varied between 1 ml/min and 100 ml/min. The channel size and flow properties in MOBIC result in flow conditions similar to those found in human veins where implant surfaces may develop biofilms. Owing to the size and concentrations of the bacteria investigated, the biocolloids in MOBIC are in the regime of dilute suspensions. The biocolloid in MOBIC is modeled as a two-phase system with the solvent modeled as a continuous phase. The bacteria are considered as a second phase dispersed in the continuum phase. This level of modeling allows use of the Discrete Phase Models implemented in FLUENT/ANSYS. The bacteria injection profiles at the inlet are generated based on bacteria densities relevant to the experiments. Gravity is varied from terrestrial to micro-gravity level to assess its impact on migration of bacteria. The biofilm is modeled as a process that includes attachment and release of bacteria based on the affinity of the surface.