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ACTIVE FLUIDS IN ENVIRONMENT: RHEOLOGICAL AND PHYSICAL PROPERTIES

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ABSTRACT

Photosynthetic carbon capture by trees and other vegetation is believed to be among the most efficient and environmentally friendly strategies to reduce CO_2 concentration in the earth atmosphere. The 2018 IPCC special report suggests that 1 billion hectares of new forest is necessary to limit global warming to 1.5 °C by 2050. However, recent studies estimate that only 0.9 billion hectares of land are available on the earth outside of cropland and urban regions for potential forest restoration. Water availability can also be one of limitations of this strategy. Biofixation of carbon dioxide by aqueous suspensions of bacteria and algae (referred to as living or active fluids) is an alternative solution for limitation of CO_2. Biofixation is 10–15 times more efficient than trees and produces biomass that has value in producing biofuels, human nutritional supplements, cosmetic products, biofertilizers and animal feed. These microorganisms are cultivated in dedicated reactors commonly referred to as photobioreactors (PBR). The physical phenomena occurring in PBR involve a sophisticated nonlinear interaction between the hydrodynamics of active fluids, biokinetic processes, radiative transfer as well as heat and mass transfer in microorganism suspensions. A high degree of success in the design and optimization of PBR therefore, relies on the proper understanding and modelling of physical properties and rheological behavior of cell suspensions. Active fluids, like suspensions of autonomous fluid particles, can show unexpected manifestations. In a recent study we showed the diffusion coefficient of cell suspensions on solid surfaces reduces with time; this reduction is directly related to the contact history between the cell and the surface. We also showed that this diffusion is a function of surface stiffness (durotaxis) and light intensity and direction (phototaxis). In our most recent study, we have focused on the new measurements of the physical properties, rheological behavior and biomass, lipid and pigment production of *Synechocystis*, an environmentally important model bacterium, under flow shear stress. This information is of primordial importance in hydrodynamical and radiative design of high performance photobioreactors.