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Mapping the biological activities of filamentous oxygenic photogranules

Hicham Quazaite, Kim Milferstedt, Jérôme Hamelin, Elie Desmond-Le Quéméner
INRAE, University of Montpellier, LBE, Narbonne, France

Abstract:

Oxygenic photogranules have been suggested as alternatives to activated sludge in wastewater treatment. Challenging for modeling photogranule-based processes is the heterogeneity of photogranule morphologies, resulting in different activities by photogranule type. The measurement of microscale-activities of filamentous photogranules is particularly difficult because of their labile interfaces. We present here an experimental and modeling approach to quantify phototrophic O_2 production, heterotrophic O_2 consumption, and O_2 diffusion in filamentous photogranules. We used planar optodes for the acquisition of spatio-temporal oxygen distributions combined with two-dimensional mathematical modeling. Light penetration into the photogranule was the factor controlling photogranule activities. The spatial distribution of heterotrophs and phototrophs had less impact. The photosynthetic response of filaments to light was detectable within seconds, emphasizing the need to analyze dynamics of light exposure of individual photogranules in photobioreactors. Studying other recurring photogranule morphologies will eventually enable the description of photogranule-based processes as the interplay of interacting photogranule populations.

Keywords: modeling, oxygen gradients, phototrophic biofilms, syntrophy, wastewater treatment, oxygen imaging