Experimental Results and Integrated Modeling of Bacterial Growth on an Insoluble Hydrophobic Substrate (Phenanthrene) - DTU Orbit (03/12/2018)

Experimental Results and Integrated Modeling of Bacterial Growth on an Insoluble Hydrophobic Substrate (Phenanthrene)

Metabolism of a low-solubility substrate is limited by dissolution and availability and can hardly be determined. We developed a numerical model for simultaneously calculating dissolution kinetics of such substrates and their metabolism and microbial growth (Monod kinetics with decay) and tested it with three aerobic phenanthrene (PHE) degraders: Novosphingobium pantaromativorans US6-1, Sphingomonas sp. EPA505, and Sphingobium yanoikuyae B1. PHE was present as microcrystals, providing non-limiting conditions for growth. Total PHE and protein concentration were tracked over 6-12 days. The model was fitted to the test results for the rates of dissolution, metabolism, and growth. The strains showed similar efficiency, with $v_{\text{max}}$ values of 12-18 g dw g$^{-1}$ d$^{-1}$, yields of 0.21 g g$^{-1}$, maximum growth rates of 2.5-3.8 d$^{-1}$, and decay rates of 0.04-0.05 d$^{-1}$. Sensitivity analysis with the model shows that (i) retention in crystals or NAPLs or by sequestration competes with biodegradation, (ii) bacterial growth conditions (dissolution flux and resulting chemical activity of substrate) are more relevant for the final state of the system than the initial biomass, and (iii) the desorption flux regulates the turnover in the presence of solid-state, sequestered (aged), or NAPL substrate sources.

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