Supplementary Material

General, a zero-order rate expression r_F can be seen as a product of a rate constant $k_{0,F}$ and active biomass X_H [36]. If no substrate is present, this rate expression equals the endogenous oxygen uptake rate OUR_e:

$$r_F = k_{0,F} \cdot X_H = OUR_e \ [g \cdot m^{-3} \cdot d^{-1}] \quad (1)$$

With this in mind, a critical characteristic length L_{crit} of the biofilm can be expressed with Equation (2). For a detailed derivation of the equations, see [36].

$$L_{crit} = \sqrt{\frac{D_F}{OUR_e}} \ [mm] \quad (2)$$

With D_F as diffusion coefficient in the biofilm $[m^2 \cdot d^{-1}]$. For oxygen, the D_F can be set as $2.1 \cdot 10^{-4} m^2 \cdot d^{-1}$. Regarding typical OUR_e within the monitored range of 18–2 $g \cdot m^{-3} \cdot d^{-1}$, a critical length L_{crit} of 1.0–1.9 mm results. The used biofilm carrier showed a biofilm thickness L_F of 6.0–8.0 mm. Therefore, the quotient L_F/L_{crit} is above 4, which is indicating a mass transport limitation within the biofilm [36]. The penetration depth ßL_F is expressed with Equation (3):

$$\beta L_F = \sqrt{\frac{2 \cdot C_{O2} \cdot D_F}{k_0 \cdot X_H}} \ [mm] \quad (3)$$

With C_{O2} $[g \cdot m^{-3}]$ as concentration in the liquid phase, here oxygen. Again, replacing the rate expression with the oxygen uptake rate results in Equation (4):

$$\beta L_F = \sqrt{\frac{2 \cdot C_{O2} \cdot D_F}{OUR_e}} \ [mm] \quad (4)$$

The range of oxygen during the aerobic batch experiments was between 2 and 4 $g \cdot m^{-3}$. The comparison of biofilm thickness and oxygen penetration is presented in **Error! Reference source not found.**. Concerning a decrease of the endogenous OUR with time due to a degradation of X_H, the oxygen penetration depth slightly increases with time. However, there is still a gap of 1.5 mm between oxygen penetration and minimal biofilm thickness which can be seen as anaerobic.

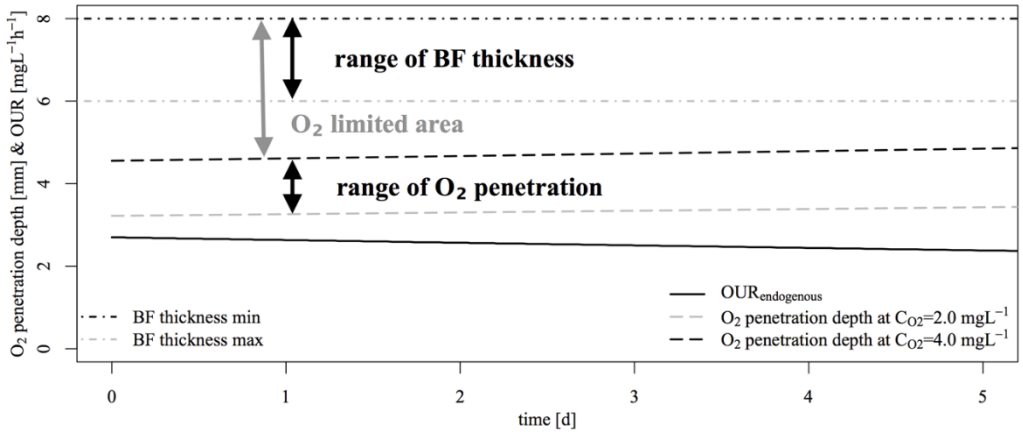

Figure S1. Diffusion limitation with respect of oxygen penetration into the biofilm.

References

1. Morgenroth, E. Modelling Biofilms. In *Biological Wastewater Treatment: Principles, Modelling and Design*; Henze, M., van Loosdrecht, M.C.M., Ekama, G.A., Brdjanovic, D., Eds.; 2008; pp. 456–492.