Investigating the Influence of Mass Transfer on Quorum Sensing in Microbial Biofilms

Roland B. Möhle[1], Erik Alpkvist[2], Katrin Bierkandt[1], Harald Horn[3], Anders Heyden[2], Dietmar C. Hempel[1]

[1] Institute of Biochemical Engineering, Technische Universität Braunschweig, Germany
[2] Applied mathematics group, School of Technology and Society, Malmö University, Sweden
[3] Institute of Water Quality Control, Technische Universität München, Germany

Introduction

- (1) Flow, (2) biofilm structure and (3) hydraulic retention time affect mass transfer of signalling compounds in biofilms.
- That means: **Quorum Sensing in biofilms is dependent on physical parameters!**

Conclusions

- Hydrodynamics cannot be neglected when doing research on Quorum Sensing in biofilms.
- Under certain conditions there is no Quorum Sensing activity in the biofilm at all.

Results

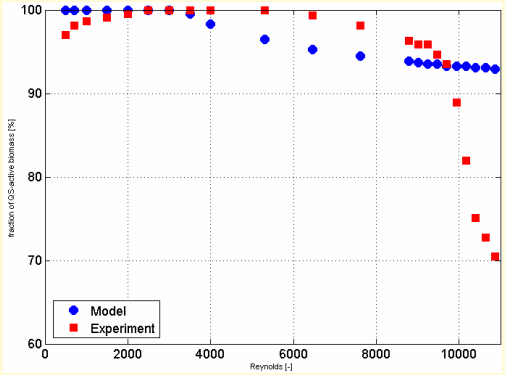
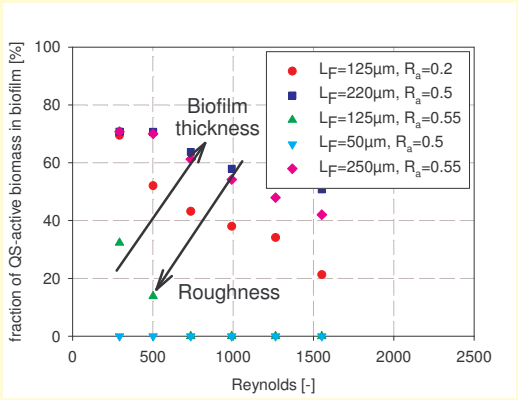


Figure 1 (left):
Light intensity (Quorum Sensing activity) decreases with increasing flow velocity in tube (model and experiment)

Figure 2 (right):
Quorum Sensing activity of different biofilm structures in dependence on flow (model)



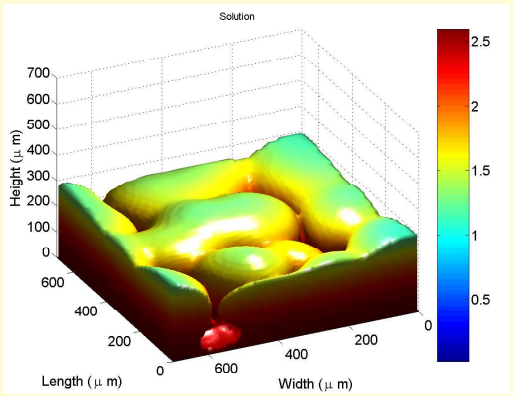
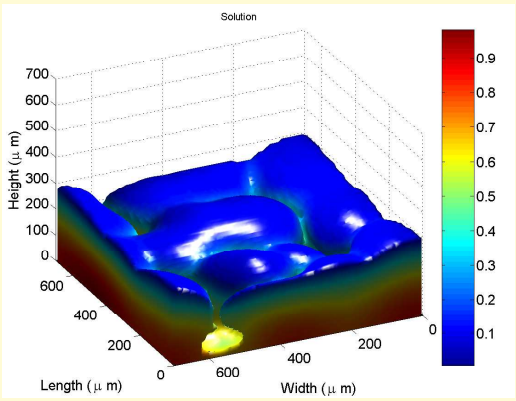


Figure 3:
Simulated distribution of signalling compound in a homogenous biofilm structure at low flow velocity (left) and high flow velocity (right)



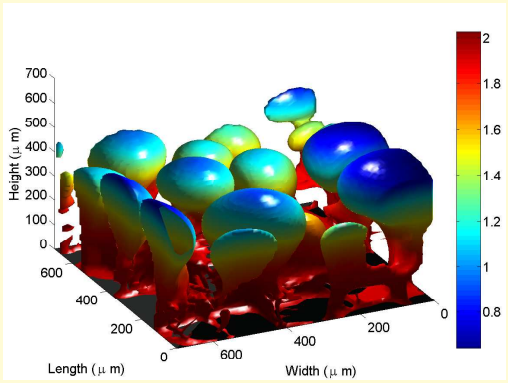
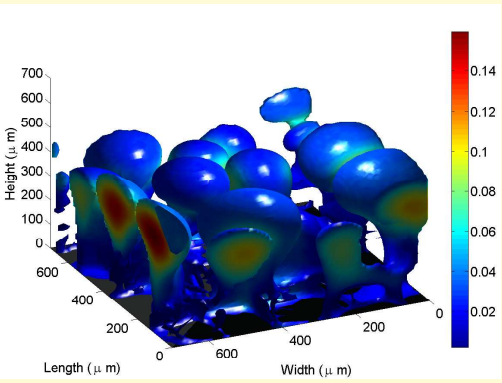
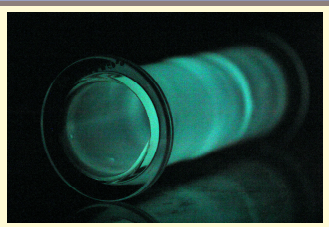


Figure 4:
Simulated distribution of signalling compound in a heterogenous biofilm structure at low flow velocity (left) and high flow velocity (right)



Materials and Methods

- Artificial biofilms consisting of *Vibrio fischeri* cells immobilised in agarose gel were applied on the inner wall of tube reactors.
- The light emission of the bioluminescent bacterium *V.fischeri* is regulated by Quorum Sensing. Hence, light intensity can serve as a measure for the fraction of QS-active biomass in the biofilm.
- Mass transfer in dependence on flow velocity has been investigated with oxygen microelectrode measurements.
- In combination with the experiments Mathematical Modelling has been used to gain a deeper understanding of the interactions between Quorum Sensing and flow conditions.



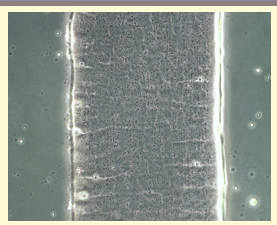


Figure 5: Segment of tubular reactor with luminescent biofilm (left), Cryosection of artificial biofilm (right, 500µm thickness)

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