Contribution ID: **112** Type: **Oral Presentation**

Study of Biofilm Structure using Advanced Imaging Techniques and Extraction of Pore Network from Simulated Biofilms

Tuesday, 23 May 2023 14:30 (15 minutes)

Pore network models (PNMs) are reduced discrete mathematical models that are widely applied to study mass and heat transfer in porous media . Considering biofilms as a kind of a porous medium, with the inter-cellular space forming the pores, PNMs appear very suitable to study the transport of substrates and products through biofilms. In electrochemically active biofilms, additionally the transport of mediators or electrons can be investigated. Biofilm morphology is quantified by using advanced imaging techniques like X-ray tomography, Confocal laser scanning microscopy (CLSM), and Scanning electron microscopy (SEM). The morphological parameters are then used to generate in-silico biofilms using averaging data on layer thickness, cell number, porosity and cell orientation. Different growth mechanisms result in different cell arrangements within the biofilm layers. The simulated biofilms are used to extract the pore networks, which form the base for the simulation of transport properties. This is shown in Fig. 1, where the PNM (on the right in blue) is reconstructed from the simulated biofilm. The mathematical method has the advantage that a wide range of biofilm structures can be studied in short time without high experimental efforts. The results are useful to understand the transport processes inside biofilms under different conditions and could be employed to predict optimal process conditions for highly efficient processes, i.e. based on optimized single or multispecies biofilm developments.

Figure 1: a) Simulation of several layers of biofilm and (b) extraction of the pore network.

Participation

In-Person

References

Q. Xiong, T. G. Baychev, and A. P. Jivkov, Review of pore network modelling of porous media: Experimental characterisations, network constructions and applications to reactive transport, J. Contam. Hydrol., 192, 101–117, 2016.

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Session Classification: MS05

Track Classification: (MS05) Biochemical processes and biofilms in porous media