Filtering with an MFC Anode:
A new concept for the integration of microbial fuel cells into membrane bioreactors.

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Motivation

Membrane bioreactors (MBRs) are a spreading alternative to conventional wastewater treatment plants. By separating the biomass from the treated water with membrane filtration instead of sedimentation, MBRs achieve higher degradation capacities with lower space requirements and a germ free outflow. The disadvantage is a high energy demand up to 10kWh/m³ [1] compared to 0,35kWh/m³ [2]. To lower the energy footprint, the combination of energy consuming MBRs with energy delivering microbial fuel cells (MFCs) has gained raising attention.

State of the art and new concept

Currently MFCs and MBRs are combined by using the cathode as membrane filter [3] or by connecting MFCs and MBRs in series [4]. Our work presents a completely new concept which simultaneously uses the anode of a microbial fuel cell as membrane filter (see figure 1) in a crossflow configuration. This leads to a high substrate supply at the surface of the anode. Furthermore a compact design of anode, separator and cathode is possible, which lowers the internal resistance. The active proton transport from the anode to the cathode with the permeate flow counteracts the performance limiting proton gradient.

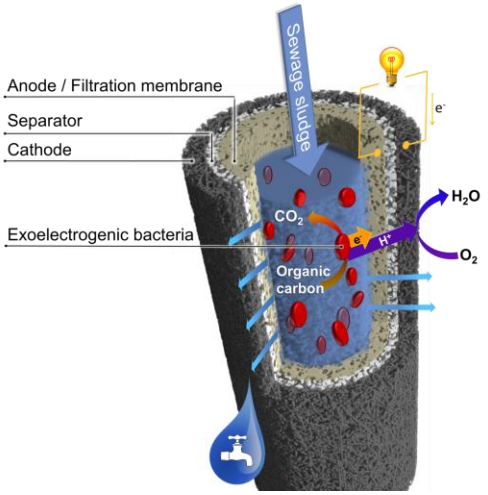

Figure 1: New concept of using the anode of a microbial fuel cell as filtration active membrane

Results

The concept was tested with sintered steel anodes (pore size 1µm) as half cells in chronoamperometric experiments at 0 V vs. NHE. In a first step triplicate experiments where performed with the material in a standard setup [5] with *Geobacter sulfurreducens*. In a second step the material was tested in a filtration setup, with crossflow velocities of 0,5m/s up to 1,5m/s and transmembrane pressures of 1bar up to 3bars. The filtration configuration increases the current densities by a factor of 2: in the non-filtrating **standard setup 5,8A/m² ± 0,5A/m²** are achieved, while it **rises to 11A/m²** with filtration at a permeate flow of over 1000 l/m²h.

After successfully demonstrating the feasibility of the concept, future work will concentrate on the assembly of a complete fuel cell and its characterization in real wastewater.

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[3] Y.K. Wang, G.P. Sheng, W.W. Li, Y.X. Huang, Y.Y. Yu, R.J. Zeng, H.Q. Yu, ES&T 45 (2011).
[4] L. Ren, Y. Ahn, B.E. Logan, ES&T (2014).
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